XJDF — Building Block for the "Printing Industry 4.0"

Whitepaper

May 2022

bvdm.

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CIP4 MEMBER

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Outlook for Section 1

XJDF will replace JDF because…

…it promotes a digital transformation by unlocking the full-potential of process automation.

This allows
to further reduce lead times,
to increase product variability,
to improve the flexibility of production planning,
to increase the reliability of production,
to achieve quality advantages
and satisfied customers.

1 Why XJDF?

More than almost any other industry, the printing industry has been experiencing an uninterrupted series of trends towards digitization for decades. As a result, this change repeatedly forced established business models to be put to the test and new goals to be defined. In all process stages, from media design to print finishing, production processes have been digitized and automated to an extent that would have seemed almost inconceivable just 25 years ago. The increasing demand for variable content, ever-shorter print runs, and expedited delivery time has been driving this development further, as well as presenting print shop logistics with new tasks. Job management and Production Planning and Control (PPC) are currently being reorganized by the Internet, mobile communications and the transfer of crucial processes to the cloud.

The upcoming digital transformation of the print and media industry towards, 'Printing Industry 4.0' is leading to an even closer integration of industry players with their customers, suppliers and partners. The distribution of tasks between the parties involved has been evolving in some areas, providing an increasing number of opportunities to add value to products and services. Not the least of this is the ability of print and media service providers to maintain an automated, dynamic exchange of information with all partners in their value network, a veritable and unprecedented end-to-end communication, all in real-time.

A decisive building block in these scenarios is the CIP4 Exchange Job Definition Format (XJDF), which marks a huge leap forward in development compared to its predecessor, the CIP4 Job Definition Format (JDF). XJDF and its sub-format XJMF, together with PrintTalk (a specification adapted to XJDF for describing commercial business processes), will permeate all processes in our industry with powerful dynamic interfaces and ensure reliable interconnection for real-time communication and automation. The final result is the vision of an 'Internet of Things' (IoT) for the printing industry.

Lessons learned from JDF user problems: Paradigm-shift with XJDF

CIP4 JDF, which was conceived around the year 2000, was already a major advance on its predecessor, CIP3 Print Production Format (PPF). However, in addition to the undisputed strengths of JDF and its sub-format JMF, weaknesses have emerged over the years that required a re-evaluation of the format. The analysis of positive and negative user experiences led to a radical redesign of JDF 1.x in 2015: JDF 2.x, which is communicated under the name of 'CIP4 Exchange Job Definition Format' (XJDF 2.x).

With its modern approaches, XJDF represents a genuine and appreciable paradigm-shift. In terms of the history of prepress imaging technology, it can be compared to the transition from PostScript to PDF: The old format was stripped down to its core requirements and enhanced with more elegant capabilities that enabled content to be exchanged in a new, more convenient and device-independent process. The result was an innovative way of enabling automation and reliability potentials in MIS-driven workflows.

Standardized XJDF vs. customized REST interface

Today, numerous print and media service providers use an MIS that is not based on XML and does not or not fully support JDF/JMF. The MIS/ERP solutions are often based on REST (Representational State Transfer) architectures—regardless of whether they were purchased 'turnkey', extended with own modules or programmed completely by the user.

The pragmatic REST programming style is quite flexible due to its Internet and cloud affinity, so that customer-service relationships as well as internal company and production relationships can be mapped in a customized manner. However, 'customized' is exactly the opposite of universal interoperability, i. e., no longer contemporary in the sense of freely expandable and arbitrarily networkable Printing Industry 4.0 structures and processes as supported by XJDF.

If you are not intimidated by the programming effort, internal and external data exchange is also possible with REST. However, the lack of standardization stands in the way of the goal of universal networking in the sense of Industry 4.0. This is because REST applications from different sources will never be able to communicate with each other automatically, because their programming interfaces (REST APIs) each speak custom languages, and thus virtually talk past each other. They are and will therefore remain unable to become standardized. In this respect, REST-based MIS/ERP systems in the printing industry do not provide a protection on obsolescence in evolution.

Whether they must remain isolated solutions is, however, a question of programmed openness. By adding open application interfaces, the system can be enabled to communicate with heterogeneous data sources — even standardized ones such as XJDF. So, for this purpose, a REST-to-XJDF API must also be programmed. However, it would be preferred if the system interface were programmed in the standard XJDF from the outset.

Future viability of XJDF

XJDF, in addition to taking into consideration modern advances in interface technology since JDF was introduced, also provides a hedge on obsolescence in its foreseeable evolution. It uses common XML technology, which enables faster and more efficient implementation in the workflow and avoids the earlier redundancies in the JDF job ticket (see Table 1 on page 12).

But that's not all: Even the industry standard XML does not mean the end of development. As XML is gradually being replaced by the leaner JSON for data exchange via web browser and mobile app, CIP4 has begun to implement an XML-to-JSON mapping for XJDF 2.1 and PrintTalk 2.1 (see Section 6.2). This further evolution will make it even easier for media IT, software and interface developers to implement XJDF in their solutions in the future. This will be particularly beneficial to cloud-based applications for location-independent access facilities.

Outlook for Section 2

XJDF will break the print process networking deadlock because…

…the XJDF concept
corrects the cardinal errors of JDF
by representing an extensible interchange format
that avoids redundancies.

XJDF provides unique product descriptions,
is able to combine multiple orders,
enables real-time communication
and programming of truly open interfaces.

2 From CIP3 PPF to CIP4 XJDF

From the perspective of print service providers as future users, XJDF offers enormous progress, whether one sells their services via an online store or not. In order to recognize the current and potential uses of XJDF, it is helpful to look back at earlier approaches and developments of 'computer-aided print production' and 'networked print shop' in order to appreciate the differences in the new possibilities of XJDF. This is the subject of the following sub-sections.

2.1 Machine preset under CIP3 PPF and Adobe PJTF (1997)

Networked production environments outside of prepress were first implemented in the 1990s by the leading German and Japanese press manufacturers, but also by the cutting system manufacturer Polar-Mohr. The client-server networks, however, embodied only 'isolated solutions' of automation with proprietary isolating protocols.

In 1995, Heidelberger Druckmaschinen AG, as a result, founded the CIP3 (International Cooperation for the Integration of Prepress, Press and Postpress) consortium, in order to convince its competitors and other solution providers with the benefits of a common data architecture. The goal was to enable the individual proprietary solutions to communicate with each other by making them accessible to any print MIS. The aim was not only to plan production, but also to control it (within the scope of the possibilities available at the time). This data architecture was enhanced by the CIP3 Print Production Format (PPF), published in 1997.

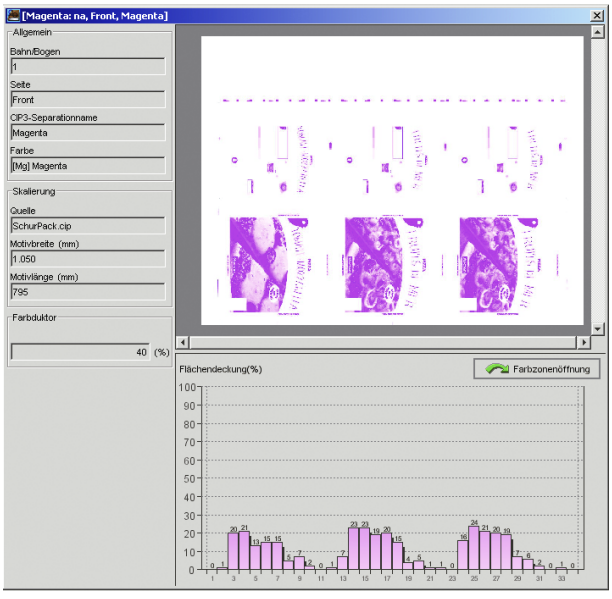


Figure 1: CIP3 PPF ink zone presetting generated from the printing form preview in Koenig & Bauer Logotronic Pro for a Rapida sheetfed offset press (Screenshot: Koenig & Bauer)

Digital job ticket

In order to be able to transport the data, the Portable Job Ticket Format (PJTF) developed by Adobe Systems became a possible solution. The PJTF embodied a digital job ticket that was generated when a print job was created, either in the print MIS, or in a comparable instance of the workflow management system. This enabled customer data to be transferred directly from the MIS to the job ticket, but a large portion of job-related data still had to be added manually. The job ticket file either ran through the prepress workflow as a companion to the PDF print file or was embedded.

Via an interface in the MIS specifically programmed for each press manufacturer involved, the PPF presetting data and the PJTF job ticket (if available), could be sent to the press network. The preset commands contained in the job ticket in question received a check mark when executed. Unfortunately, this was the only visible 'feedback' from the system.

2.2 Computer Integrated Manufacturing with CIP4 JDF (2000) and PrintTalk (2004)

The general trend towards Computer-Integrated Manufacturing (CIM) did not stop at the printing industry. Flexibility in production control could be increased by not only transmitting information to the production systems, but also by reporting status information back to the controlling instance in the opposite direction. This required bi-directional communication between the print MIS and the production environment. It is for this reason, under the aegis of the CIP3 successor CIP4 (International Cooperation for the Integration of Processes in Prepress, Press and Postpress) — the Job Definition Format (JDF) and its response subset Job Messaging Format (JMF) were created. The name JDF gives it away: technical data and the digital job ticket are combined into one, with the functionality of PJTF 1.1 (1999) being integrated into JDF. From 2000 onwards, JDF/JMF spread worldwide in numerous MIS solutions and interfaces to presses and finishing machines.

Methodology of Interoperability Conformance Specification (ICS)

The JDF format specifications have been supplemented by additional specifications that summarize relevant elements from JDF for specific tasks (e. g., for networking the MIS with other processing systems) and specify them with structured rules for the relevant process steps. With such an Interoperability Conformance Specification (ICS), it is possible to avoid having to map JDF elements that are not needed at the individual intersections in the process, along with irrelevant or even redundant data. By focusing on a specific application purpose, an ICS ensures clarity and thus facilitates the development of cross-manufacturer interface solutions.

PrintTalk interface for commercial processes

Initially independent of CIP4, the PrintTalk programming community was formed with the aim of defining a best-practice specification for an open communication interface between brand owners and other print media buyers on the one hand and print service providers on the other. The PrintTalk 1.x specification does not use pure XML like JDF, but cXML, a standardized XML vocabulary for business and commercial applications.

Since 2004, the PrintTalk specification has been further developed by CIP4. With the integration of PrintTalk 1.5 into the CIP4 environment, JDF was supplemented by the description of commercial processes. PrintTalk 2 for XJDF now also supports end-to-end digital communication in the commercial sector. There, it can benefit from the capabilities of the XJDF specification in order to better-describe processes and products in detail.

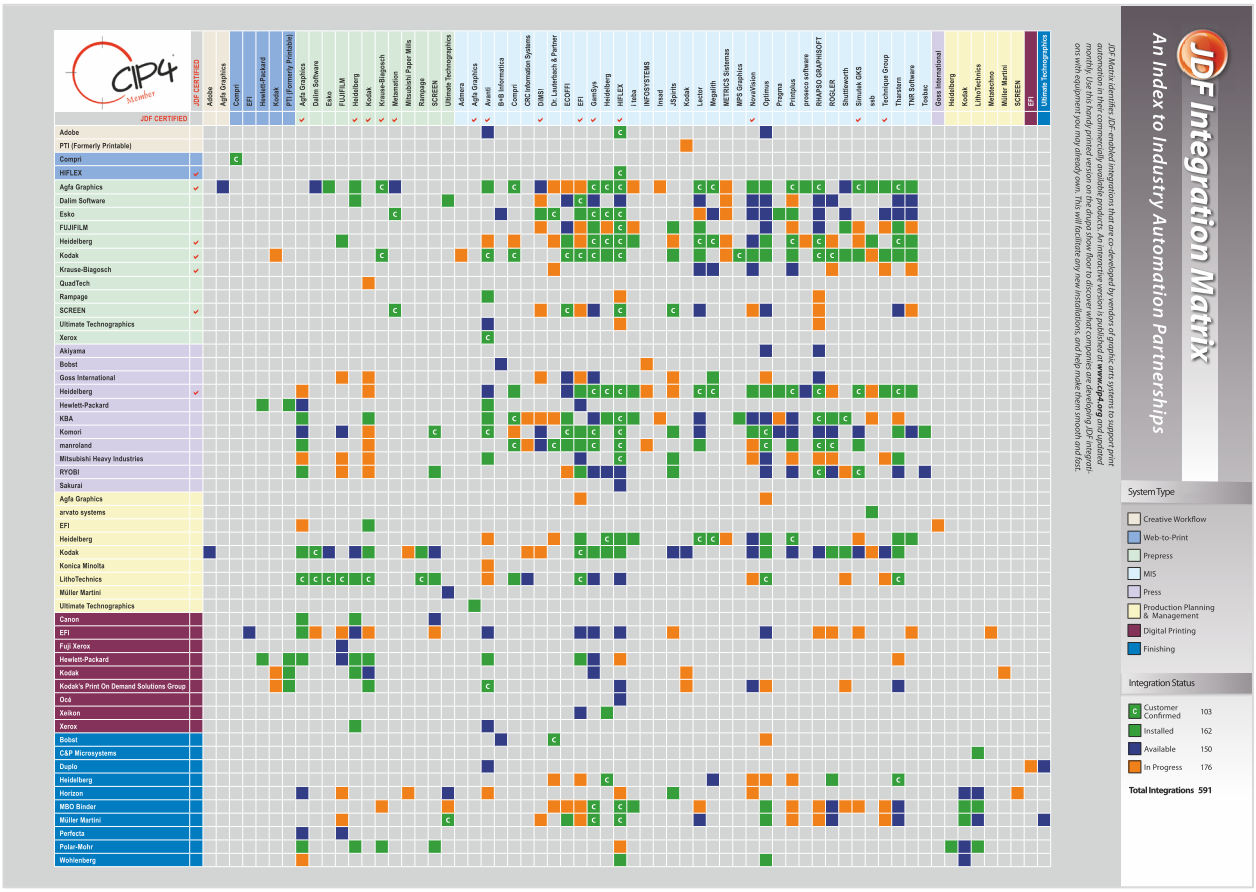


Figure 2: Example of the 'JDF Integration Matrix'. This static interoperability overview from April 2012 has now been replaced by a web database. In future, it will also list XJDF-compliant applications, which will then be characterized by universal interoperability flags.

2.3 Why JDF led to a dead end

As the most widely used markup and meta-language for structured documents, both human- and machine-readable standard XML was the best choice to promote the implementation of JDF. As a result of this decision to standardize upon XML, it led to a more global adoption. Consequently, there are very few networking and interfacing solutions for production systems that do not understand JDF/JMF. The key to the equally widespread dissatisfaction lies in the content quality of the XML code used. The left column of the Table 1 (see page 12) lists confirmed inadequacies.

Different JDF dialects prevent understanding

From the user's point of view, there is one weakness in particular: the problem of networking systems from different manufacturers and the fact that the interface is only open to selected partners. Although JDF-XML is structurally compliant with the standard, it is largely up to the software providers and machine manufacturers to decide how they implement the JDF/JMF in their interfaces. As with PPF, they are allowed to include 'private data'. In the end, the interfaces of different providers cannot communicate with each other without further ado—and therefore cannot be extended with common XML editors.

This has limited the choice of upcoming investments in production technology to date, since the individual components must fit together to enable end-to-end networking. As before, printers must rely on the huge JDF Integration Matrix (see Figure 2) if one wishes to view which solutions communicate with each other and which do not. Ultimately, the multitude of JDF dialects counteracts the intended openness of the standard, and the Interoperability Matrix reflects the dead end that JDF had reached.

2.4 Why XJDF (2018) breaks the deadlock

To address the issues of JDF, CIP4 evolved the format specification to JDF 2.0 starting in 2015. This upgrade, released in early 2018, is also known as Exchange JDF (XJDF). The 'first name' alone tells us where XJDF primarily differs from JDF: in the unlimited exchangeability of information—in other words, what constitutes true interoperability: any manufacturer's systems can communicate with those of other manufacturers, and all actors and process steps can be included. In the design of XJDF, CIP4 took into consideration countless suggestions from the participants, which ultimately brought about the paradigm-shift mentioned in Section 1. Table 1 shows which fundamental changes have also been made.

The main conceptual change is that XJDF no longer attempts to model an entire job as a single large 'job ticket'. XJDF specifies an exchange format between two applications that are assumed to have an internal data model that is not necessarily based on XJDF. As a result, each XJDF ticket specifies a single transaction between two parties. A single order can be modelled as one or more XJDF transactions, which also allows for combined forms. In other words, XJDF enables exact print *product* descriptions from which *process* descriptions can be derived in a flexible and dynamic manner.

From a purely technical point of view, XJDF relies upon 'well-formed and valid' standard XML: the code is available in pure, dialect-free syntax (well-formed) and its structure can be checked with a formal schema (valid). For this reason, the corresponding XML schema (.xsd) is also provided for each XML-based CIP4 specification. In contrast to XJDF, JDF validates the XML together with JDF's own concepts (allowing for dialects). There, individual dialects can 'spoil' the well-formed syntax.

XJDF thus 'forces' the interface definitions to be kept open. This makes the interfaces expandable in the long term and thus future-proof. XJDF will therefore prove to be the key to complete automation and thus an essential building block for 'Printing Industry 4.0'.

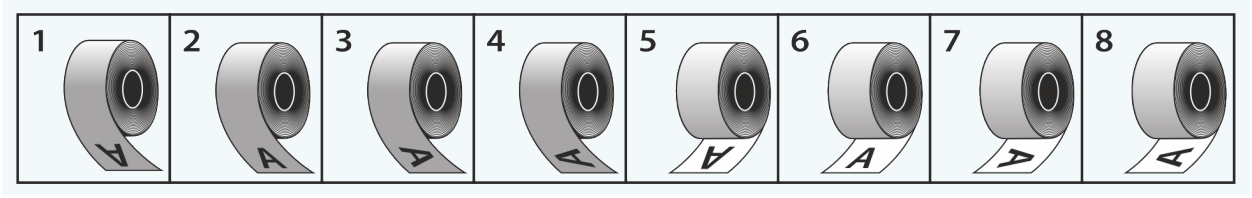


Figure 3: Long- and short-grain format on the top or bottom side of the web in web printing. Already defined in JDF, XJDF extends the applicability beyond heatset web offset printing to newspaper and publication gravure processes.

Shortcomings in JDF 1.x	New approach with XJDF 2.x
From the rigid job ticket…	**…to the simple, extensible exchange format**
The analog job ticket is only of limited use as a model for the digital job ticket, because all job data must be communicated to all machines, even if only selected information is required.	The structure of XJDF has been significantly simplified so that production systems and applications can be integrated more quickly, easily and robustly. XJDF is designed as a pure exchange format ('Exchange JDF') that can also be extended. It describes both the interface between the customer and the central 'MIS' as well as its interfaces to the applications and presses and devices in production that execute certain tasks.
From redundant job ticket…	**…to clear product description**
JDF should represent a complete electronic job ticket. In JDF, there were several ways to describe the requirements at the right level of detail, but no fixed place to do it. Despite updates at each process station, no strict order emerged. Thus, applications had to search for the required attributes in a huge file.	XJDF avoids redundancies, i. e., the number of methods for describing similar product and process features is limited to one if possible. The process and system settings are mainly generated automatically from the PDF and now describe products in an unambiguous manner and in a unique sequence of process steps. A complete ticket is no longer generated and passed on, but only one transaction between a controller and individual applications in the process.
From inadequate job description…	**…to product flexibility**
Only one product fit into the digital job ticket. Product changes and versions as well as mixed forms could only be mapped to a limited extent.	In XJDF, several products can also be processed in one order or several orders in a gang form, which is what makes complex online automation possible in the first place. Short-term or systematic changes (versioning, personalization, individualization and cross-media) can be easily described, right through to further processing.
From the well-formed JDF-XML…	**…to the well-formed, valid standard XML**
JDF-XML was standard XML, but additionally used JDF-specific concepts. This meant that solution and interface developers were dependent on specific JDF tools. JDF implementation was therefore initially the responsibility of software, press and device manufacturers. Each of them developed turnkey solutions only for their own systems, without thinking outside the box; thus, 'private' (proprietary) dialects emerged.	Like JDF, XJDF uses well-formed XML 1.0, but without its problematic constructs. The lack of additional concepts eliminates proprietary data constructs. The XML schema used ensures that the XML is recognized as valid. This means that XJDF is adapted to common development tools and programming styles, which facilitates implementation. When adopting JDF elements, XJDF elements maintain consistency by simply adding new elements to the existing human- and machine-readable elements; however, backward compatibility is limited due to the propriety of JDF structures.
From the purpose-built tool…	**…to the extensible networking language**
JDF was primarily used to process jobs, taking advantage of the already existing local networking of production systems with the print MIS.	XJDF allows networking beyond production systems with online platforms (transmission of print orders via the Internet, web store connection) or between different companies (via ERP).
From static…	**…to the agile developed data model**
The process and interface descriptions in JDF were sometimes too static and not easily expandable.	In XJDF, basic elements have been defined in such a way that the specification is extensible for newly added product properties and process steps.

Table 1: Paradigm-shift with XJDF

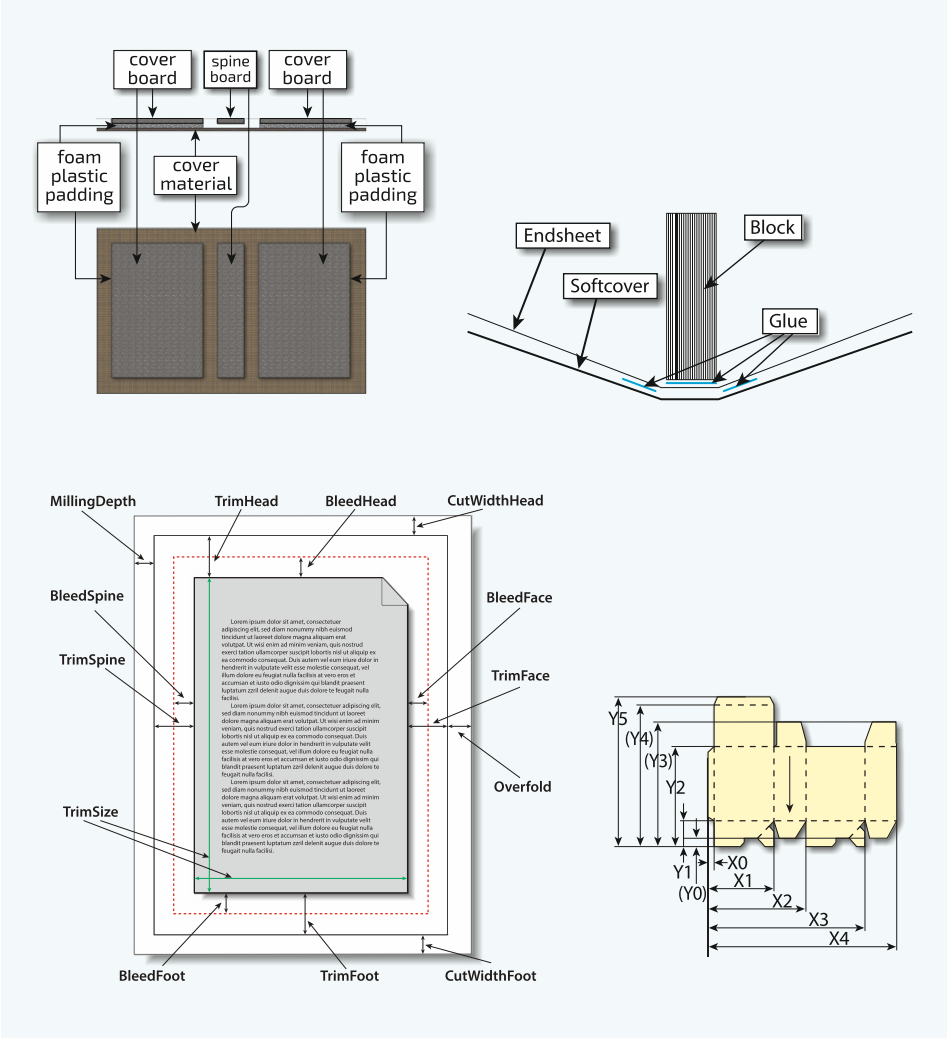


Figure 4: XJDF did not reinvent the wheel. Many definitions contained in JDF, such as hardcover and softcover, PDF boxes in the page description, or folding cartons, have been adopted in XJDF. This means that XJDF remains partially backward-compliant with JDF. XJDF provides new capabilities in more detailed print product descriptions, from which the process-descriptions are derived in a flexible, and dynamic manner.

Following JDF and JMF, XJDF also contains a message sub-format: XJMF. It is used in the same way, but due to the high level of detail aimed at in practice, it acquires a disproportionately higher significance, also with regard to real-time responses.

XJDF is partially backward compatible with JDF 1.x, so existing JDF interfaces do not have to be reprogrammed from scratch. The decisive factor is the ability to write extensible interfaces using XJDF's standard XML and thus also to be able to extend JDF interfaces with XJDF. As a benefit, anyone using existing JDF-compliant production systems should actually be able to expect the manufacturer to provide XJDF in the medium term as part of a firmware update. Whether, and how quickly this happens will be dependent upon a user-base of MIS-driven print service providers demand for this functionality.

2.5 Further development of XJDF and JDF format specifications

In mid-August 2020, the CIP4 organization published the revised versions of XJDF 2.1 and PrintTalk 2.1. Since then, XJDF has been applicable not only for sheetfed offset and digital printing, but also for processes in heatset and coldset web offset printing and publication gravure. There, the two-part 'MIS to WebPress ICS' (Commercial 1.3 and Newspaper 1.3), which was primarily tasked with filling gaps in the JDF format specification, has thus become superfluous.

Nevertheless, the many JDF solutions on the market will continue to be supported by CIP4 by further developing the JDF format specification in parallel with XJDF. The JDF specification, which was last updated to version 1.7 in August 2020, contains enhancements for digital printing, quality management and automatic imposition. The CIP4 consortium intends to develop JDF and XJDF simultaneously in the medium term, so that JDF 1.8 is expected to appear together with XJDF 2.2 and JDF 1.9 with XJDF 2.3.

Outlook for Section 3

XJDF, together with PrintTalk, will revolutionize print shop networking because…

…for both formats,
ICS programming tools have been developed
to meet the requirements of the digital transformation.

These tools support online-printing,
end-to-end data communication
from the customer to production systems,
as well as real-time reporting of events
towards an unprecedented level of detail —
particularly with regard to quality requirements
and results.

3 End-to-end communication with XJDF and PrintTalk

If digital information is transmitted bi-directionally between the ends of a communication chain without media discontinuity, this is called end-to-end communication. Compared to JDF, XJDF and PrintTalk 2 improve end-to-end communication even more when products and processes are described in greater detail: between the customer and the print MIS, and between the print MIS and production. Measurement systems and sensors provide precise feedback in real-time, which can be forwarded to the customer, supplier or other partners if required.

3.1 The role of PrintTalk

PrintTalk 2 for XJDF is an XML specification that can be used to communicate both business data and transactions (PrintTalk itself) and print product descriptions (specified by XJDF). The core of PrintTalk is formed by defined business objects, i. e., the commercial objects and actions of the print job: tender/quotation (selection features, deviations, with/without negotiation), paper qualities, paper selection (quantity, batch, ID, name, availability, price, contact), order, cancellation, confirmation, rejection, data delivery with confirmation of receipt, proof release (request, response), order status (request, response), invoice.

The version numbers of PrintTalk are based on the XJDF version that is referenced. PrintTalk 2.1 therefore references XJDF 2.1. While PrintTalk 1 was still based on an outdated cXML, PrintTalk 2 uses standard XML just like XJDF. This means that PrintTalk 2 also allows mapping to JSON in order to implement data exchange via web browser and mobile app. The networking of the commercial print MIS modules benefits greatly from the paradigm-shift from JDF (PrintTalk 1.5) to XJDF (PrintTalk 2).

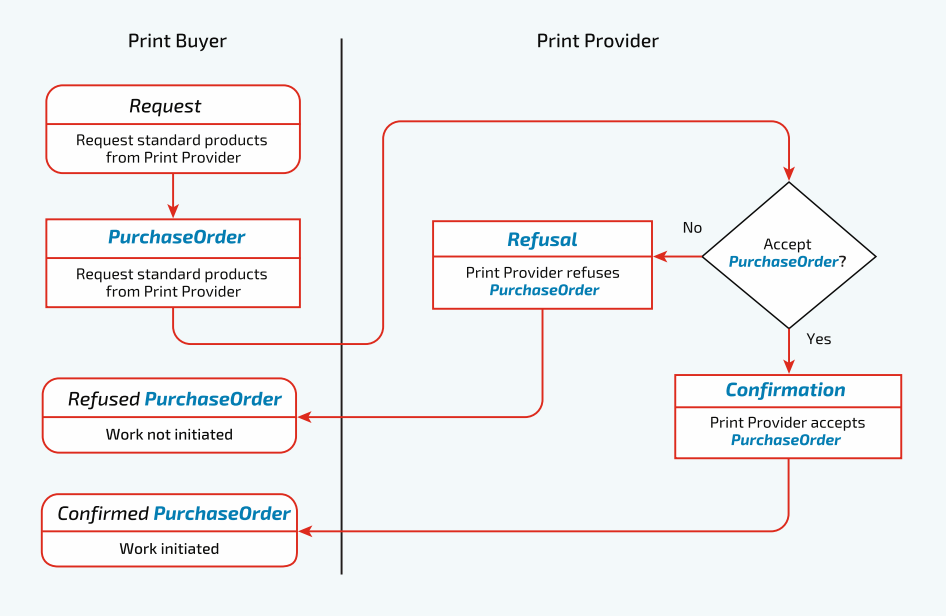


Figure 5: Typical PrintTalk flow chart of a print media purchase at a fixed price. The buyer selects a standard product, which the print service provider accepts as an order if the parameters are correct, i. e., if they cannot be rejected.

3.2 Tasks of the XJDF/PrintTalk Interoperability Conformance Specifications (ICS documents)

As was already the case for the JDF format specifications (see Section 2.2) interface descriptions according to the ICS methodology (Interoperability Conformance Specification) have also been developed for XJDF and PrintTalk. An ICS describes the logical interaction of the central controller (manager) with the other instances (workers) within the value chain, in relation to a specific task. The specification combines only the XJDF and/or PrintTalk elements relevant for this task. The focus on specific application purposes ensures clarity and facilitates the development of cross-manufacturing interface solutions.

Since XJDF is backward compatible with JDF, older ICS releases implemented in existing interfaces can continue to be used. The development of an ICS is based on demand. XJDF created the prerequisite for automating e-procurement (generating and invoicing jobs online) and the real-time exchange of detailed quality data by means of appropriate ICS—both in the sense of the best possible networking and automation (Industry 4.0).

New interface specifications for print media buying and quality data exchange

Up to now, three ICS documents have been developed based on XJDF or PrintTalk 2. In December 2019, CIP4 completed work on the Customer to Automated Print Procurement ICS (Cus-APP ICS) interface specification for buying and selling print media. It is still based on XJDF 2.0 and PrintTalk 2.0.

In August 2020, the Quality Control ICS (QC ICS) interface specification for standardized quality data exchange was added. It consists of two parts: The Customer to Quality Control ICS (CusQC) deals with the quality requirements and their technical representation in the product description. The MIS to Quality Control Device ICS (MisQC) enables these requirements to be met by providing control through the central instance, the print MIS. The two specific parts were developed on the initiative of and with the significant participation of the bvdm.

While PrintTalk 2 relies on XJDF, XJDF can in principle also manage without PrintTalk. Accordingly, an ICS refers either on XJDF only or on PrintTalk as well. Elements of the XJDF CusQC can interact with PrintTalk if they are to be linked to commercial processes, but they do not have to. The XJDF Cus-APP ICS, on the other hand, requires PrintTalk elements to be taken into account, since these are mainly used to map commercial processes.

Table 2 shows an overview of the division of tasks between the two format specifications and the three interface specifications. The ICS contents are presented in more detail below, as they illustrate the potential of XJDF and PrintTalk for end-to-end communication.

Format specification	Task
XJDF	Describes the print product in detail and, with XJMF for real-time feedback, accompanies it through the entire job control, manufacturing and logistics process.
PrintTalk for XJDF	Defines the commercial infrastructure and the quotation, order, cancellation and payment processes that take place within it.

Interface specification	Task
XJDF Cus-APP ICS	Creates a job ticket in the web-shop from the description of the print product (print file, run length, inks, substrate, etc.) using XJDF and PrintTalk and calculates the corresponding prices.
XJDF Quality Control ICS	Enables the internal and external exchange of quality data.
→ Part 1: Customer to Quality Control ICS (CusQC)	Allows the customer to define the quality targets using XJDF, whereby already defined process steps from PrintTalk can be used (e. g. if special quality requirements have an impact on the price), but do not have to be used.
→ Part 2: MIS to Quality Control Device ICS (MisQC)	Defines the bi-directional exchange of quality data between MIS/ERP and the production systems, including the installed measuring devices and sensors, via XJDF and XJMF.

Table 2: The division of tasks between the XJDF and PrintTalk 2 format specifications, as well as the interface specifications (ICS) developed for them.

Customer to Automated Print Procurement ICS (Cus-APP ICS)

The Cus-APP ICS automates transactions between print media buyers and printers/finishers and makes it easier to map commercial processes in real-time. Together with the Quality Control ICS (see next page), the Cus-APP ICS is intended to facilitate the implementation of the new XJDF standard in practice.

The main motivation for providing such an ICS was the increasing processing of print jobs via the Internet. This is because without standardized customer interfaces, the development of customer- or platform-specific automation solutions involves considerable effort. With the interface description standardized in the Cus-APP ICS, regular as well as occasional customers can be connected more easily and cost-effectively.

This ICS also enables small print service providers to standardize their commercial processes with XJDF and PrintTalk. As a result, it helps to create a certain level playing field with the large online print shops, since all market participants can find and use the same standard conditions and automation prerequisites.

The specification intro explains as the purpose of the Cus-APP ICS:

- Standardizing the business transactions between print buyer and print service provider. This is particularly useful in defining those subsets of the XJDF and PrintTalk specifications that are relevant from the customer's point of view for the automated procurement of standardized print products (APP).
- Describing the interaction of the workflow business objects required to submit jobs from a print buyer to a print provider, and the mechanisms by which the print provider can either accept or reject the job and provide job status information to the print buyer (see also Figure 5 on page 16).
- In doing so, orders can either be specified completely and in detail for 'blind' exchange or refer to preconfigured products by identifiers that have been synced offline.

The Cus-APP ICS describes the purchasing process starting with the online order. The tender/inquiry and quotation process, which is already defined in PrintTalk, is not specified again in the ICS.

Quality Control ICS (QC ICS)

The Quality Control ICS (QC ICS) supports the automated exchange of quality data for a product, both for each individual copy and for a print run as a whole. The Customer to Quality Control ICS (CusQC) defines the quality targets and their mono-directional transport from the customer to the print service provider. In order for this to ultimately become bi-directional communication, the MIS to Quality Control Device ICS (MisQC) first reports the corresponding quality measurement data from the measuring devices in production and logistics to the MIS/ERP, which can forward a selection of this data to the customer.

The division of communication between the customer-to-MIS and MIS-to-production strands makes it easier for the print service provider to control which process and quality data should and may be exchanged with the customer. Thus, on the one hand, XJDF/XJMF enables the print service provider to improve its process stability and product quality through more detailed production analysis, and on the other hand, to work more efficiently with its customer.

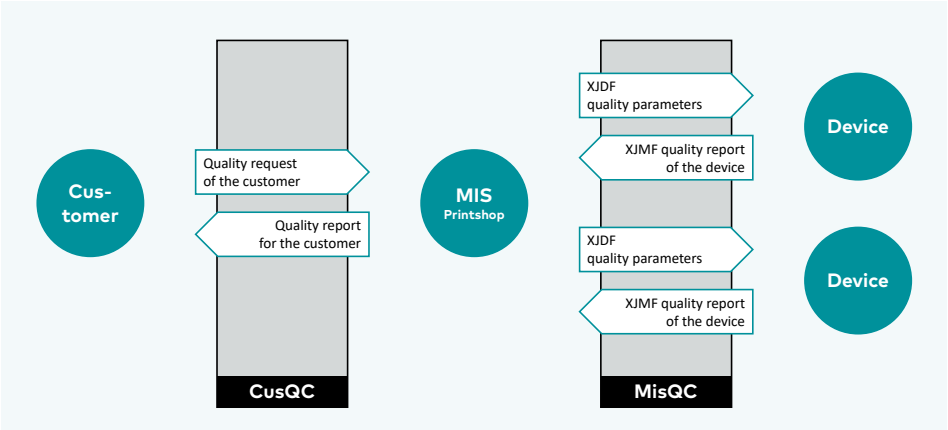


Figure 6: Interaction of the Customer to Quality Control ICS (CusQC) and MIS to Quality Control Device ICS (MisQC) interface specifications

Although the Quality Control ICS is aligned with the Cus-APP ICS, it can also be implemented without it. This means that the ICS part CusQC allows the customer to define quality targets in the print job using XJDF, where the definitions from PrintTalk can be used, but do not have to be.

MisQC enables bi-directional communication with the production environment (measuring devices, sensors and interfaces on presses, machines, devices and control consoles): The MIS/ERP sends data for quality control via XJDF together with the data for production control, which is immediately answered by the measuring devices and sensors in the form of XJMF quality measurement data. Collaboration with PrintTalk is neither required nor planned here.

The full potential of QC ICS is realized when all production systems—i. e., not only the presses but also the postpress units—are extensively equipped with measuring devices, cameras and sensors. Only when all relevant quality data are recorded and automatically mapped in the MIS/ERP or a special quality monitoring software (see also Section 4.4), a standardized and automated quality control system can be implemented without gaps. The result is a largely error-free and uninterrupted production process.

Together, CusQC and MisQC enable a seamless quality workflow. CusQC facilitates the communication between customer and print service provider in online portals (especially if PrintTalk is also used) and the integration of software solutions for quality assurance and quality monitoring. Thus, CusQC maps the quality-relevant processes between the customers and the print service provider, while MisQC exchanges quality data internally between the print MIS and the networked production systems.

Extensibility of the Quality Control ICS (QC ICS)

The target values from ISO 12647-2 for paper white and primary colors in offset printing were already referenced in JDF 1.5 and could be adopted in XJDF. In XJDF 2.1, the target values from ISO 12647-3 and -4 for newspaper and magazine gravure printing are also referenced [1]. The CusQC can therefore also refer to these values. Independently of this, interface developers have the option of allowing users to specify individual quality targets.

The CIP4 consortium wants to use XJDF to communicate as many quality parameters as possible with a high level of detail. Up to now, the focus of development has been on printing quality features such as color information or the accuracy of the color register. Thus, the current status of the two ICS parts largely covers the process quality from prepress to press. It is planned that higher versions of the QC ICS together with XJDF will be supplemented by quality criteria for finishing processes and inspection systems (dynamic image analysis). Which parameters will be available and when, depends on the cooperation of the relevant solution providers.

Outlook for Section 4

XJDF will enable 'printing industry 4.0' because...

...new opportunities arise
to automate collaboration with customers,
suppliers and production partners
and at the same time make them more secure
and transparent.

It opens up opportunities
for innovative business models,
for example, by integrating customer processes
into the company's own value chain.

4 With XJDF towards printing industry 4.0

The terms Industry 4.0, Digital Transformation, Artificial Intelligence (AI) and Internet of Things (IoT) describe visions and concepts that will also change the printing industry and are already doing so in some cases today. The digitization of all production and business processes enables ever closer and more complex interlinking of processes, even beyond the boundaries of one's own company—with customers and suppliers as well as with partners at the same stage of the value chain. Information is available in real-time wherever it is needed. All processes, from order placement to payment, are accelerated. The increasing degree of networking also creates new opportunities to expand the range of services.

4.1 Production processes

The starting point for such a Printing Industry 4.0 scenario is the internal networking of production processes. This presupposes the comprehensive digitization of production systems, which is already well advanced in many areas (e. g., in prepress, modern offset presses and digital printing systems). However, there are often still gaps in digitization because older printing and postpress equipment (including decades-old platen or cylinder presses) is still in use and a retrofit is either not possible or not worthwhile. Here, PDA terminals are often used to provide a rudimentary link to other operational functional areas (e. g., sales, warehouse, work preparation, MIS). Particularly in connection with company mergers, printing companies are often faced with the task of networking heterogeneous production environments across manufacturing sites.

With XJDF, many production processes can be monitored and controlled or regulated without delay or interruption. The increasing number of sensors installed in production systems (cameras, measuring devices, transducer in open and closed loops), which constantly report their information to the central instance (print MIS, workflow controller), expands the quantity of process variables and product parameters accessible for this purpose. The full potential unfolds in automated control loops, where the production specifications are transferred from XJDF to the production systems and the production data are reported back via XJMF in real-time.

In sheetfed and web presses, important hardware requirements are often already met by equipping them with inline measuring devices and image analysis and inspection systems; in digital production printing, the sensors extend into postpress and inserting. However, the majority of systems currently installed, particularly as relate postpress, are still far from having the full arsenal of measuring technology at their disposition. Apart from this, the solutions are currently only networked via proprietary protocols, since JDF/JMF has so far not been able to query detailed parameters due to its sluggishness in data communication and the lack of ICS for quality control (see Section 4.4).

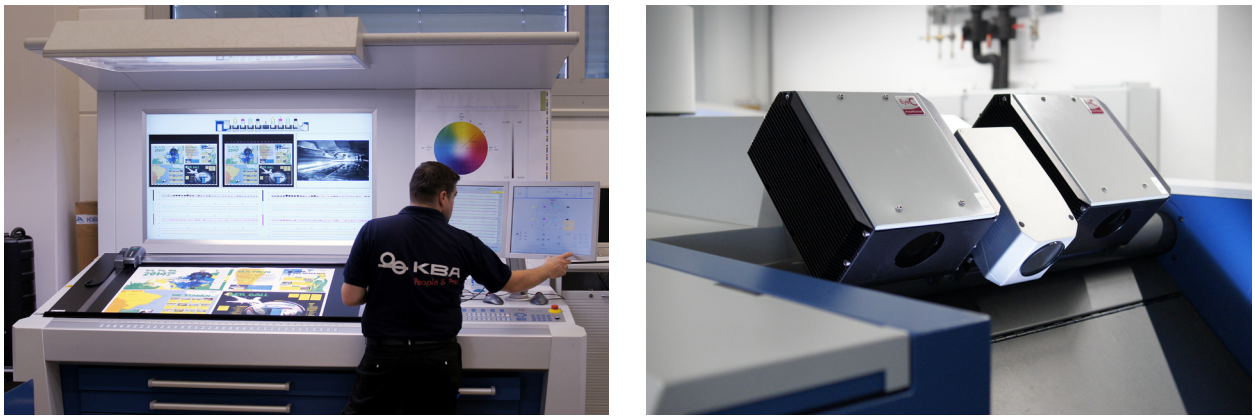


Figure 7: Control systems such as QualiTronic from Koenig & Bauer, in their maximum configuration, continuously compare the print run sheets to the OK copy and the PDF file. By checking inking and register as well as all subjects for faultlessness, a volume of data accumulates that only XJMF could communicate to the MIS completely in real-time. (Photos: Dieter Kleeberg)

Since sluggishness prevented real-time communication, there was no question of immediately passing on measurement data which went beyond status and control comparisons. However, this means that the opportunity is lost to obtain the certainty at an early stage—i. e. already during the production run—that the production was error-free. Such information is in turn desirable in order to be able to plan production after printing in a binding manner. The necessary technical potential is certainly available in color measurement and inspection systems: Firstly, the quality of the entire print image is recorded in the greatest detail; secondly, these data are collected completely from the start to the end of the print run and can be communicated immediately thanks to XJMF and MisQC.

XJDF also provides parameters and elements in the logistics area. Many print shops already have larger storage and transport capacities and are expanding them into logistics profit centers. The drivers of this trend are ever shorter runs and shorter delivery times for standardized print products, which are preferably configured and ordered online. At the same time, this requires new end-to-end digitally controlled logistics concepts. In this context, XJDF is also a metadata connection point for merchandise management systems if, for example, advertising inserts are to be created from these systems and fed to the relevant carrier media.

XJDF application scenario: Artificial intelligence for gang forms

A particular challenge, especially with online printing, is to print jobs from different print media buyers that match in terms of color, run length (if necessary by placing several copies) and printing stock using a gang form. In the past, the impositioning of complex gang forms required time-consuming operator intervention. Today, this process can be fully automated. In addition to static solutions, real-time dynamic AI algorithms are now also used for this purpose. Table 3 gives an overview. With the real-time dynamic solutions, gang forms can be generated within a few seconds, and new jobs can be included according to priority and suitability until shortly before imaging of the printing plates.

Production monitoring and control in print finishing

Not all applications require expensive special measuring devices or probes to report information about the production process back to the controlling instance. Many control tasks can be solved with inexpensive mini cameras and downstream image analysis. The Swiss company Hunkeler AG, a well-known solution integrator for digital printing and paper processing, can equip its own and other modules with its own inline measuring or inspection technology.

In its maximum configuration, the Hunkeler Control Platform (HCP) is able to display the entire production process in real-time, eject any duplicates and, in individualized print runs, insert missing copies into the workflow. At the same time, it also monitors and controls general quality parameters, such as laser perforations on the running web. These parameters — like the entire production progress — can be communicated to the customer on request, but only via the proprietary HCP solution.

Nevertheless, this example already shows the enormous benefits: The 'stop-and-go' still typical of many postpress lines is being replaced by a 'green wave'. With XJDF/XJMF, the advantages of this kind of 'Finishing 4.0' could also be used outside the Hunkeler world across all manufacturers.

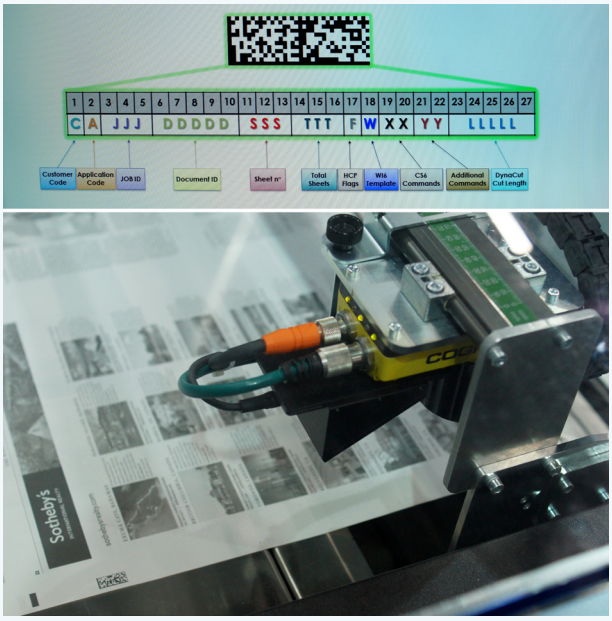


Figure 8: Hunkeler uses inline cameras to capture Data Matrix codes for production monitoring in digital web printing. The mini cameras can also be used to check selected quality parameters. (Photos: Dieter Kleeberg)

The AI software PerfectPattern sPrint One is the pioneering application, which calculates signatures and gang forms in real-time, including the cutting and folding scheme, and can also plan and optimize production processes (e. g. press assignment, job sequence, throughput times). Kodak was the first licensee of the cloud engine in 2017; online printing giant Cimpress was the first to use the full cloud version in 2018. Paper merchant Sappi introduced the OctoBoost cloud solution, based on the sPrint One AI engine, to the trade public in 2019. The OctoBoost module Print Efficiency dynamically schedules print jobs.

With the Heidelberg Prinect Station Gang Assistant, the world's largest press manufacturer has a comparable AI solution — with the difference that XJDF interfaces have long been included in all Prinect modules.

In the future, XJDF will enable automated gang forms generation to realize its full potential by extracting product-related XJDF metadata from PDF/X-6 print documents (see also Section 5). XJDF would also be able to automatically continue the product workflows of the individual components after the gang form has been separated, i. e. to reassign the products to their individual further processing and logistics processes and to control these processes.

Real-time dynamic cloud-based solutions, input: XJDF, JDF 1.6 — output: XJDF, JDF 1.7, native

MIS or workflow module	AI core	Ganging	Nesting	PPC *
Enfocus Switch: Ganging-Webservice	PerfectPattern sPrint One (Impressed)	✓	×	×
Heidelberg Prinect: Signa Station	Heidelberg Gang Assistant	✓	×	×
Heidelberg Prinect: Signa Station Packaging Pro	Heidelberg Gang Assistant	✓	✓	×
InSoft Automation: Imp Planner/Gang in four-pees network with callas pdfToolbox Server	PerfectPattern sPrint One (Impressed)	✓	✓	✓
Kodak Prinergy Cloud: Dynamic Print Planning	PerfectPattern sPrint One	✓	×	✓
Krause Imposition Manager (KIM): AUTOsPrint	PerfectPattern sPrint One (Impressed)	✓	×	×
PerfectPattern sPrint One 3.x, standalone: • Cloud software engine for all functions • Console (cockpit for browser)	PerfectPattern sPrint One	✓	✓	✓
Printplus DRUCK: Imposition	PerfectPattern sPrint One	✓	×	×
Sappi OctoBoost: Print Efficiency	PerfectPattern sPrint One	✓	×	✓

* × in the PPC column means that the AI engine or imposition solution does not provide a production planning and control module because a PPC already exists elsewhere into which the gang form is transferred.

Static solutions without AI, Input: JDF 1.6 — Output: JDF 1.6/1.7, CIP3 PPF, native

MIS or workflow module	AI Core	Ganging	Nesting	PPC
Dynagram DynaStrip	×	✓	×	×
EFI Metrix	×	✓	×	×
Esko Automation Engine with Plato and i-cut	×	✓	✓	×
Hybrid Software: packzimizer module in packz/stepz	×	✓	✓	×
tilia labs: Phoenix	×	✓	✓	×
Ultimate Technologies Impostrip: AutoFlow Sprint	×	✓	✓	×

Table 3: Solutions for automated imposition of gang and multiple-up printing forms. XJDF and JDF 1.7 basically allow cross-order printing forms to be generated and production planning and control (PPC) data to be updated at the same time. (All information without guarantee.)

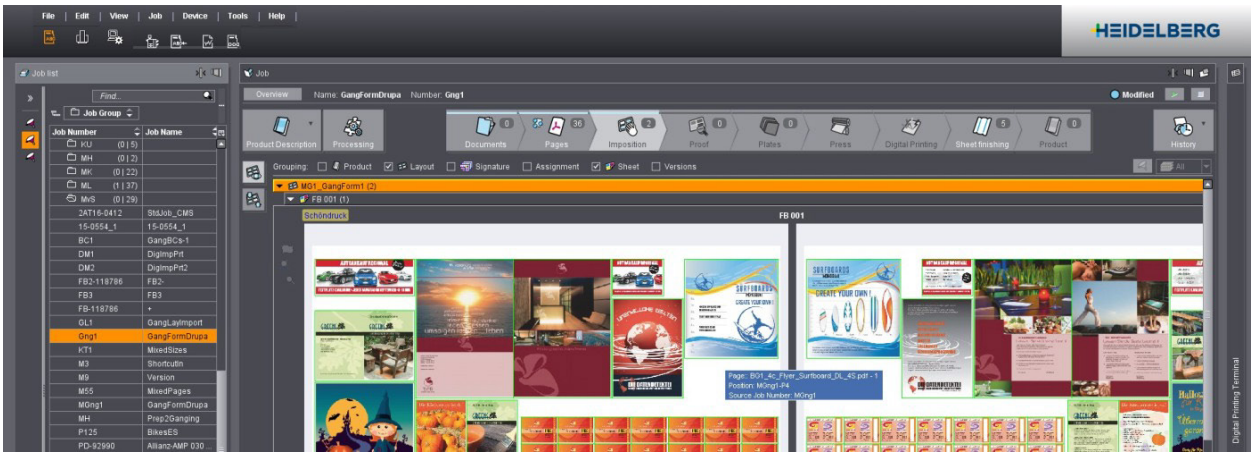


Figure 9: Heidelberg has already implemented XJDF in its Prinect software. Gang forms are visualized in the Prepress Manager cockpit as a result of the Gang Assistant. (Source: Heidelberg)

As long as XJDF-compatible workflows—such as Heidelberg Prinect—do not yet exist across the board and cannot yet access PDF/X-6 jobs, sPrint One and Heidelberg Gang Assistant (if non-Heidelberg systems are connected) must still import the JDF 1.6 job tickets of the individual jobs and export the gang form to JDF 1.7. This latest JDF format is capable of creating gang forms with both non-interleaved subjects and interleaved blanks ('ganging' and 'nesting') and offers the advantages of XJDF in terms of the subsequent need for their separate processing. The German system integrator Impressed GmbH and the Austrian workflow consultant Peter Kleinheider (Calibrate.at) are currently the only providers to program and configure corresponding PDF workflow interfaces for sPrint One, the latter also at users' premises.

4.2 Supplier processes

When purchasing materials such as paper and printing inks, print shops today often still use the telephone or e-mail to enquire about availability and prices or to initiate orders. This slow, inefficient and, above all, error-prone way of handling the ordering process in hectic situations (such as rush jobs) is no longer up to date. Although individual supplier interfaces to the print MIS provide improvements, they are not the last word. XJDF now enables standardized interfaces which, thanks to end-to-end communication, support both printers and suppliers in forward-looking materials planning.

Paper, ink and other material suppliers are generally not yet connected to the MIS/ERP of the print service provider in such a way that automated ordering is possible, which flows directly into the supplier systems and can thus be processed automatically. An XJDF interface of the MIS/ERP that can be used by every partner could considerably simplify and accelerate material purchasing. The prerequisites would be XJDF-capable MIS/ERP software and a mapping (translation) into the suppliers' SAP XML. The standard XML used in the XJDF code is once again the key to this.

Zaikio—connectivity platform with XJDF background

The software company Crispy Mountain, known for its cloud-based print MIS Keyline, was acquired by Heidelberger Druckmaschinen AG at the beginning of 2020 and has since been operating under the name Zaikio GmbH. This German company operates Zaikio, another cloud-based collaboration platform, together with Heidelberg Kiel. According to Managing Director Christian Weyer, Zaikio aims to "bring together as many industry participants as possible". This includes print shops, customers, brand owners, suppliers, and software and press manufacturers.

In principle, the platform account should give every user access to all connected hardware and software solutions with a single login. Access rights management ensures that all participants can only use the offers and functions that have been approved for them. In the future, the platform is to be expanded to include a robust, web standards-based event system called 'Loom', which will even enable complete workflow control.

The main goal is initially to exchange data between the participants in a simple manner on the basis of continuously automated process chains. Until now, this has failed due to non-standardized interfaces, especially since even JDF could not solve this problem as originally intended. Zaikio wants to establish interface compatibility through a central app management called Mission Control, which acts as a hub for all connected solutions and is announced for mid-2022. Participants can dock there with existing applications, presses as well as new Zaikio apps and thus read and write product and process information across applications in the workspace assigned to them.

The first networking solutions are already available under the name Zaikio Procurement for purchasing paper, printing inks and other consumables. Here, print shops can purchase paper, ink and other consumables directly from their MIS, production or warehouse software—or with the Zaikio Procurement app directly via the browser—trigger orders with the connected suppliers.

One example of this is the handling of paper purchasing between M&E Druckhaus, Belm (Germany), and the paper supplier Sappi. M&E uses the Heidelberg Prinect Business Manager app for this purpose, as its entire cross-site production is also largely XJDF-networked with Prinect modules. M&E orders only one type of paper from Sappi, which has been defined as the M&E in-house standard. The quantities of paper (at least 20 tons per delivery) are ordered according to the paper stock in the warehouse rather than depending on print jobs. The price and availability of the material can be called up at any time. M&E thus saves costs through material standardization and automated procurement, while Sappi benefits from automated sales processes and strong customer loyalty.

However, the interface apps to Zaikio are not standardized. Instead of XML or XJDF they are programmed as REST API, mapped to JSON (for mobile devices). Where it makes sense, however, the semantics of the Zaikio interface apps are based on XJDF in the background, which was ensured by the Heidelberg-Prinect programmers involved.

Zaikio owner Heidelberg expects XJDF and thus JSON to emerge as key elements in the future and find their way into the interfaces of the participating solutions—especially in direct app-to-app communication—i. e., without the Zaikio functions Mission Control, Rights Management, and Event System. After all, if the apps of the various manufacturers are also to exchange data directly with each other, the level of detail of which goes far beyond the Mission Control data model, everything can only come down to the XJDF standard. Zaikio could therefore prove to be an interesting field of activity for gaining experience with XJDF implementation and Printing Industry 4.0.

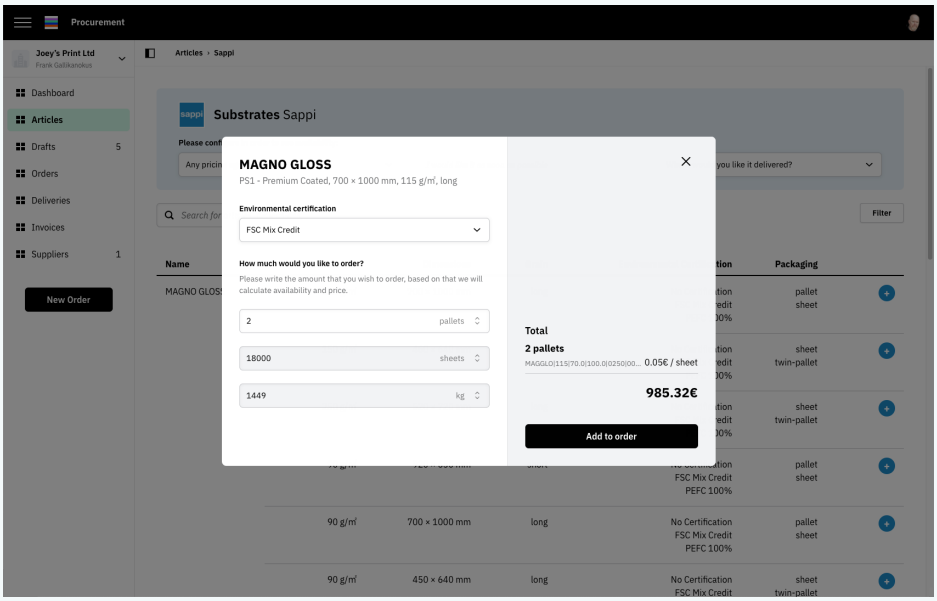


Figure 10:
The Zaikio Procurement app in use by Sappi for an incoming paper order
(Source: Zaikio)

4.3 Customer processes

Integrate web stores into XJDF communication

Networking with print media buyers is also more or less common—for standardized print products via an open or closed web-to-print store. Many print and media service providers use Magento, the popular open-source platform, for this purpose. In some cases, they even use it to develop web store solutions for their customers. Magento configures its interfaces in parallel in both PHP and XML—good for the use with XJDF and PrintTalk 2.

There are considerable differences in the extent to which processes are integrated between customers and print MIS (e. g., quotation, configuration and ordering, release, job tracking, invoicing) and between print MIS and production systems, and how much is automated. Until now, the possibilities have been limited by the restraints of JDF. The full networking and automation potential can only be tapped with XJDF.

Under XJDF (and even more so in conjunction with PrintTalk 2 or the new ICS), web store networking with customers also has an effect upon networking with production partners. Product configuration can now be carried out in greater detail and variety without the process reaching its previous JDF limits, when quality specifications were not possible, and the selection of product features was still strictly tied to the production systems available in-house. As the print media buyer designs his print product in a much freer web-store dialog, only the intended product description (Product Intent) is initially formatted in XJDF. The job ticket construct is only completed with a concrete technical XJDF process description during the purchase order process. Thanks to the external networkability, services provided by partners can now also be taken into account when generating real-time calculations.

Automation of print media purchasing

The XJDF implementation in web-to-print and MIS/ERP should in future also enable print service providers to simplify certain processes for their customers or to relieve customers of certain tasks altogether. For example, a separate XJDF interface specification is available for automated print media procurement (APP): With the help of the XJDF Automated Print Procurement ICS (Cus-APP ICS), XJDF- and PrintTalk 2-compliant print service providers can make it easier for their customers to procure the desired print products (see also Section 3.2).

Automated purchasing processes are particularly beneficial for cooperation with regular customers, who order at high frequency. The APP can be combined with a permanent quality monitoring system (see Section 4.4). XJDF will be the integrating standard for both application areas in the future. Print service providers whose interfaces are prepared for this are able to offer attractive customers more benefits and thus increase their loyalty.

When connecting large print media buyers, such as retail or tourism groups, which often use specific industry standards to automate their procurement processes, XJDF as standard XML lends to becoming the common language.

Linking with the customer's inventory management systems

Large corporations have long since automated their procurement processes. In many of these companies, the marketing of goods and services is also largely standardized and automated through regularly printed advertising materials or online advertising.

The Global Data Synchronization Network (GDSN) for article master data has established itself in the retail sector for the procurement of goods. Fast-Moving Consumer Goods (FMCG) in particular, use applications to organize and manage not only the purchase of goods, but also the associated images & texts along with presentation guidelines (i. e., to provide and manage them in suitable views and meta-documents, FMCG V4.x software has been widely used for this purpose). The content is usually generated by the goods manufacturer and retrieved by the retailer for ultimate inclusion in online stores and printed advertising media.

If XJDF is used for commercial printing in the future, product images and descriptions from the customer's systems could be automatically imported into the print production process in conjunction with GDSN and FMCG data. This means that extensive customer processes such as automated print procurement (specified in the XJDF Cus-APP ICS) must be integrated, in the context of which the advertising artwork is to be created digitally. Because GDSN communicates its information using GS1 XML vocabulary and FMCG V4.x also uses XML, corresponding XJDF interfaces can be programmed. It makes sense to fill prefabricated templates at the customer's site and then distribute them to the print shops as PDF/X — in future with 'XJDF inside'.

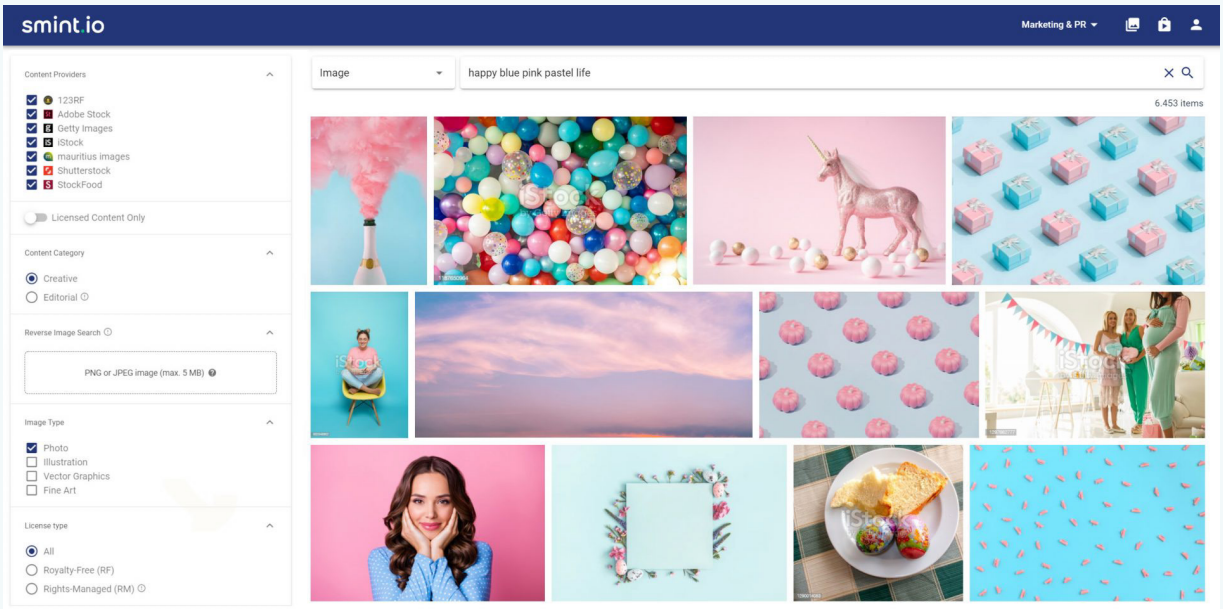
But advertising content is only complete with image pictures. Unlike article images, these illustrative photos and graphics, such as sunny vineyards or happy families, must be purchased by retailers from stock photo agencies. Instead of ordering the image rights individually and decentrally from the individual stock photo providers, retailers will procure their media centrally and automatically in the future, bundled thematically. A specialized content license platform called smint.io already exists for this purpose.

Incidentally, other industries also access such services for their advertising, e. g., the hotel industry and tour operators. Instead of the GDSN standard, the XML format OTDS (Open Tourism Data Standard) has been used there since 2012, at least in Germany. The accommodation data and media files of the local service providers are centrally hosted in the OTDS database and can be used by travel agencies, airlines and hotel portals for bookings or integrated into advertising campaigns and travel catalogs. These data are linked to form an illustrated text with term and price tables.

Standardized metadata in the article and image pictures allow largely automated use. Ideally, these metadata then also contain specifications as to how the image is to appear in online and print media—quasi the above-mentioned display guidelines. Without intervention by the print media buyer, the metadata (specified in the XJDF CusQC) are transferred to the XJDF product description and used for quality control during production. The requirements for color reproduction play the biggest role here.

At the large retail and tourism companies, digital transformation in this area is already advanced. XJDF is the (now finally available) chain link between print media buyers and print service providers.

Figure 11: Hits of an image query in the image rights platform smint.io (Source: smint.io)



Automated management of customer relationships

Some print MIS use the principles of expert systems, including in CRM modules. Such modules are capable of independently analyzing customer characteristics and preferences from the available customer and order data and deriving individual measures for maintaining the customer relationship. The analysis is based on criteria such as creditworthiness (sales, payment behavior and deadlines), negotiation behavior, order volume and intervals (occasional or regular customer, periodicals in the publishing sector, weekly and seasonal rhythms in advertising printing), and product complexity (type, variety and interlinking of the print and digital media ordered).

From master data, key figures and customer history, the CRM modules automatically generate, for example, individualized advertising mail, newsletters or e-mails with discount offers for regular customers, graded according to their sales and payment behavior. A reminder function ensures that the sales department follows up with the customer by phone at the right time. Production planning is affected by prioritizing customers: periodically reserving printing capacity, giving preference to bad payers, etc. With PrintTalk 2 and XJDF, especially the XJDF Cus-APP ICS (see Section 3.2), such CRM modules can be used even more effectively.

Linking to the customer's production processes

Since XJDF uses standard XML, it can in principle not only communicate with the SAP systems of customers and suppliers, but also dock with industrial customers on production lines that use OPC UA (Open Platform Communications—Unified Architecture). OPC UA is the standard for machine networking in mass production. In the printing industry, JDF/XJDF takes on the same role, adapted to the industry-specific requirements of the batch production.[1]

XJDF networking with OPC UA could be interesting for industrial printing applications in which printing technology and other industrial production technologies are integrated. XJDF would then offer printers the opportunity to integrate directly with the production processes of other industries and thus create new service offerings.

[1] Batch production refers to the production of related products in different versions, which are manufactured in larger quantities as batches, series or lots either simultaneously or consecutively, on the same production lines.

4.4 Quality management processes

Automation of quality monitoring

Modern industrial print production requires automated and networked quality monitoring. The same applies to the communication of quality requirements and quality results. The suitable specification for this is the XJDF Quality Control ICS (see Section 3.2).

XJDF, and especially the Quality Control ICS part MisQC, allow quality data of all kinds—from color and register data to visual artifacts—to be collected, analyzed and communicated in real-time without human intervention. If required, selected quality data can also be transmitted to customers according to the CusQC specification.

XJDF is capable to communicate large amounts of data with a variety of quality parameters. At the same time, these quality data are linked to the production parameters. Sensibly aggregated and evaluated over longer periods of time, valuable information can be gained from this to stabilize and increase process and product quality in automated production, even in the medium and long term.

However, in order to fully exploit the potential of XJDF for quality assurance, the number of XJDF interfaces for quality data acquisition should now grow. This is the task of the press and software suppliers.

Cross-company quality monitoring

The iQIP quality monitoring solution installed in some larger print shops is to become XJDF-compliant in the medium term. The company iQIP GmbH & Co KG is one of the founding members of the XJDF Quality Control Working Group and is heavily involved in the (further) development of CusQC and MisQC. The quality parameters included in iQIP, the extensive quality history, the quality analysis running permanently in the background, and above all the online quality database already form a good basis for a powerful XJDF scenario for fully automated communication of quality data. The solution is also used by some large print media buyers to ensure a uniform and high-quality level of their print products in cooperation with various print service providers. Independently of this, iQIP has meanwhile also become a Zaikio platform partner (see page 27).

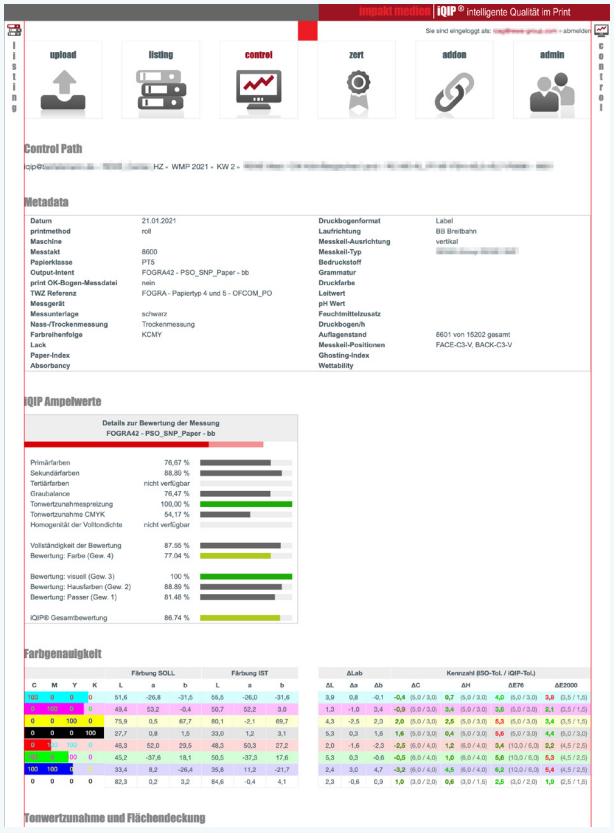


Figure 12:
In the future, iQIP plans to use XJDF to exchange quality data. (Screenshot: iQIP)

Outlook for Section 5

XJDF will open up new ways of exchanging data because…

…XJDF extends the compatibility with international standards for print data and color communication.

Metadata and content data can be better linked and made implemented into solutions for process control on mobile devices.

5 The role of XJDF in document and color data exchange

Embedding XML and JSON metadata in PDF/X files with XMP

PDF files contain metadata that is automatically generated with the document and can be viewed in the 'Properties' menu of the PDF software. These metadata include the PDF version and the creation program, describe the settings used to create the document, and provide information about embedded fonts and access rights. Such metadata can be expanded later for specific purposes. To ensure that the entries can be easily retrieved later, they must be standardized. The open standard XMP (Extensible Metadata Platform) used for this purpose is applied not only in PDF files but also in TIFF files.

XMP can be used to embed XML data and its JSON equivalent in PDF/X print files, which also makes the metadata usable for cloud hosts and mobile devices. How XMP metadata are embedded in the PDF/X document or alternatively attached in a so-called filial file is specified in the elementary part 1 of the international standard ISO 16684 [2]. ISO 19445 [3] supplements the specification with requirements for transporting visualization, status and approval information as XMP metadata for images and documents.

XJDF metadata in PDF/X and PDF/VT files

In current PDF/X-4 workflows, the XJDF product description must still be passed to the respective process step as a separate job ticket. Since ISO 16684-1 created the structural prerequisite in 2019 for writing XML and JSON metadata in PDF/X print files via XMP, ISO 21812-1 [4] made it possible to write an XJDF product description directly in PDF/X-6 files. In this way, the PDF/X-6 print file with its 'self-containing XJDF' (as the IT term goes) makes its own way through the workflow and supplements any missing information in the relevant MIS modules. It automatically organizes and starts all the necessary process steps, which then report their XJMF messages directly and dynamically in real-time to the MIS controller. The CIP4 XJDF developed outside ISO was chosen for the self-containing architecture in ISO 21812-1, rather than the 'PRX' (Print Requirements eXchange) or 'PQX' (Print Quality Exchange) specified in ISO 20616 [5]. This is because the PRX/PQX format, which was developed on the initiative of the American IDEAlliance organization, represents an isolated solution solely for quality data exchange, which does not even use the 'old' JDF (see Table 4).

The architecture and core of the metadata specification standardized in ISO 21812-1 build on PDF 2.0 published at the end of 2020 (ISO 32000-2 [6]). This means that only PDF/X-6 (ISO 15930-9 [7]) and the PDF/X-6 based PDF/VT-3[1] (ISO 16612-3 [8]) will be able to use this specification.

[1] VT stands for Variable Transactional and Trans-Promotional work, i.e. documents with variable invoice data and possibly linked advertising content.

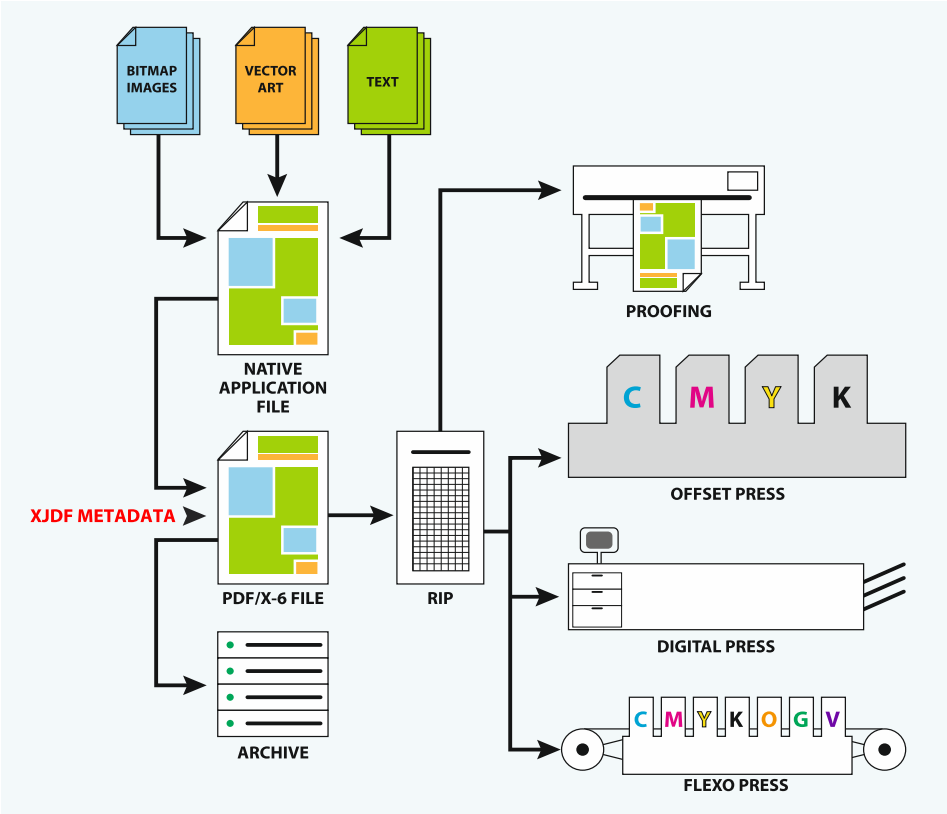


Figure 13: Embedding XJDF metadata in the PDF/X-6 workflow (source: PDF/X-6 Application Notes; 'XJDF Metadata' added)

Unlike PDF/VT, PDF/VCR[1] (ISO 16613-1 [9]) for printing variable layouts is not intended to be upgraded from PDF/X-4 to PDF/X-6 due to lack of practical need. In this way, only one other ISO standard will be modified so that the applications concerned can access XJDF directly—namely ISO 19593-1 [10]. This standard defines how processing steps contained in PDF documents, e. g. for varnishing, die-cutting, creasing or Braille, are to be stored in a standardized manner.

XJDF also communicates spectral data

XJDF supports the exchange of all types of color data, including spectral data. This data can be 'packaged' in the container format CxF3—also specified in XML. This was not yet possible with JDF. The use of CxF3 data for automated color data exchange is governed by ISO 17972 [11]. With the help of CxF/X-compliant spectral data, colors can be described even more precisely than with CIELAB coordinates and can be processed and controlled according to the state of the art. This pays off especially with spot colors, particularly when they are lightened or printed over each other. With CxF3 support, XJDF not only opens up new possibilities for automation in packaging printing. If it turns out that the SCTV method standardized in ISO 20654 [12] also brings advantages for standardized four-color printing (and then called CTV), XJDF is already prepared for this. SCTV calculates spot color tone values from spectral data and — as an alternative to the Murray-Davies formula used today — can generate colorimetrically based tone value curves.

[1] VCR stands for Variable Content Replacement.

General differences and future viability		
Feature	**CIP4 (XJDF/XJMF, PrintTalk)**	**ISO 20616 (PRX/PQX)**
Conceptual holism	XJDF/XJMF and PrintTalk describe the entire print job. The quality data exchanged with the ICS parts CusQC and MisQC can be embedded in the print job in a fully compatible way. The main focus is on comprehensive networking and end-to-end communication.	PRX and PQX are stand-alone 'specifications' that only describe the partial process of quality data exchange between the print buyer and the print service provider. Not compatible with industry standards JDF and XJDF. The technical quality of the standard is questionable, as PRX/PQX allow almost arbitrary and unstructured content.
Embeddability as metadata in PDF	ISO standard as of PDF 2.0 and thus as of PDF/X-6 as well as the PDF/VT digital print conventions based on it	Not specified as meta format for PDF
Cloud and mobile applications	JSON mapping for XJDF/XJMF	PRX/PQX are so far only available in XML.
Machine-readability and granularity (detailing)	Structured fields for well-defined attributes	Few structured fields containing non-machine-readable data structures (simple text)

Differences in quality data exchange (especially CusQC/MisQC vs. PRX/PQX)		
Feature	**CIP4 (XJDF/XJMF, PrintTalk)**	**ISO 20616 (PRX/PQX)**
Color and separation codes	Separations can be linked to the underlying separation names in the PDF. The CxF3 color data exchange format is fully supported.	CxF3 is incompletely implemented, which means that the communicated target values cannot be assigned to the color separations.
Measuring patches geometry	Well-defined positioning of color-linked measuring patches	Measuring patch geometry not linked to color definitions
Communication concept	The ICS parts CusQC and MisQC were developed in parallel and aligned with the CIP4 specifications.	PQX reports measurements without reference to product and PRX timestamp. PQX and PRX were developed with a time lag with incompatible namespaces.
Capability for end-to-end communication	CusQC defines the customer-to-MIS communication. MisQC defines the MIS-to-measurement device communication.	PRX and PQX define customer-to-MIS communication only. A common communication with the production (via PQX) is missing.

Table 4: Exemplary differences between the CIP4 specifications and the PRX/PQX format, which is inadequately specified in ISO 20616.

Outlook for Section 6

XJDF is easy to implement because...

...it is based on standard XML,
conforms to common programming styles,
is backward compatible with existing JDF interfaces,
harmonizes perfectly with PrintTalk,
and brings mature developer tools.

6 Specifications and Developer Tools

6.1 CIP4 Internet resources

In addition to its Internet presence, the CIP4 organization also has an extensive technical public space based on the proven Atlassian Confluence Enterprise Wiki (https://cip4.atlassian.net/wiki/spaces/PUB/). Here, software and interface programmers can find all the necessary documentation and tools.

Even non-registered users can directly download format specifications, XML schemas, ICS documents and tools here. These are listed, clearly arranged and linked in the following tables 5 to 8—including the still valid JDF specifications.

Valid CIP4 specifications	Publication	Reference	Resources
CIP3 PPF 3.0 today included in JDF/XJDF	1998-06-01, 2000-11-19	PPF 3.0	Specification Addendum 1a
JDF 1.6 Update from JDF 1.5 for existing workflows and machine interfaces	2018-02-28	JDF 1.6	Specification Schemas*: lax / strict
JDF 1.7 Update from JDF 1.6, including new features for digital printing systems, quality control and ganging software	2020-08-16	JDF 1.7	Specification Schema
JDF 2.0 Upgrade JDF 1.5 to JDF 2.0 = XJDF 2.0	2018-02-28	XJDF 2.0	Specification Schema
XJDF 2.1 Update from XJDF 2.0	2020-08-16	XJDF 2.1	Specification Schema
PrintTalk 2.0.1 for XJDF Upgrade from PrintTalk 1.5	2020-03-03	XJDF 2.0	Specification Schema
PrintTalk 2.1 for XJDF Update from PrintTalk 2.0.1	2020-08-15	XJDF 2.1	Specification Schema

* The XML processor retrieves the strict schema by default when it validates the contained standard XML elements using XML namespace. The lax schema is retrieved when user-defined elements and attributes are present, but error-free validation as standard XML should still be performed.

Table 5: Format specifications (PDF file) and XML schemas (XSD). Currently, the format specifications JDF 1.8, XJDF 2.2 and PrintTalk 2.2 are under development; the current builds are available after user registration.

Interoperability Conformance Specifications (ICS)		Publication	Reference	Resources
XJDF Automated Print Procurement ICS (Cus-APP ICS)		2019-12-17	XJDF 2.0 + PrintTalk 2.0	Cus-APP_L1-2.0
XJDF Quality Control ICS (QC ICS)	Customer to Quality Control ICS (CusQC)	2020-08-15	XJDF 2.1 + PrintTalk 2.1	CusQC_L1-2.1
	MIS to Quality Control Device ICS (MisQC)	2020-08-15	XJDF 2.1	MisQC_L1-2.1/ MisQC_L2-2.1

Table 6: Availability of the XJDF ICS documents. Currently, ICS Cus-APP 2.0+, CusQC 2.2, and MisQC 2.2 are being developed for XJDF; builds are available after registration.

ICS	Abbr.	Purpose, use case
Base ICS 1.5	Base	Basic definitions referenced by other ICS documents
Common Metadata for Document Production Workflow ICS 1.0	PDF/VT	Standardized metadata embedding in structured page description data (here: not yet PDF/X-6 but PDF/X-4 for variable transaction data printing according to ISO 16612-2:2010)
Integrated Digital Printing ICS 1.5	IDP	Digital printing applications of all kinds
JMF ICS 1.5	JMF ICS	Communication via JMF reports
Layout Creator to Imposition ICS 1.4	LayCrImp	Interface between layout application and prepress workflow
MIS ICS 1.5	MIS	Cooperation between MIS and production systems
MIS to Conventional Printing ICS 1.3	MISCPS	Cooperation between MIS and sheetfed offset presses
MIS to Finishing ICS 1.3	MISFin	Cooperation between MIS and the controller of a further processing system; replaces Binding ICS 1.0
MIS to PrePress ICS 1.5	MISPRE	Connection of the MIS to prepress systems
Prepress to Conventional Printing ICS 1.4	PRECP	Interface between prepress and offset printing
WideFormatPrintingICS 1.4	DWF	Large format digital printing

Table 7: JDF ICS releases which are still usable under XJDF (→ to download source). Updates to 1.7 and upgrades to 2.1 for Base, JMF ICS, MIS and MISCPS are to be developed in parallel until summer 2022; the builds are accessible after user registration.

Tool		Purpose, use case
Programming tools	Alces	JDF integration
	Bambi	JDF Device Simulator (simulation of production systems)
	EasyXJDF	XJDF integration
	JDFEditor	Creating and modifying XJDF and JDF code
	JDFUtility/Toolbox	Validating JDF code online
Libraries and parsers	JDFLibC, JDFLibJ	C++ or Java library for JDF
	xJdfLib	Java library for XJDF
	PrintTalkJ	Java library for PrintTalk 1.5 (no longer supported)
	xPrintTalkLib	Java library for PrintTalk 2.x
	CIP4-Logos	Designing user interfaces, manuals, websites

Table 8: Open-source offerings for developing and implementing CIP4-compliant applications.

Anyone who wants to actively participate in CIP4 as a programmer or expert can also register without paid membership. Then he or she will find all the specifications and tools currently under development in the 'Spec Incubator' and 'Tools Incubator'. In the meantime, the 2.2 builds of the format specifications XJDF and PrintTalk as well as various ICS releases are available there; even those still developed for JDF continue to be optimized.

Confluence is used to organize and record virtual and physical meetings and publish the results of CIP4 activities. In addition, there is a system dashboard where free registered users can virtually collaborate and take over certain project tasks directly. The dashboard system is based on Atlassian Jira, which was created for task and project tracking and will be familiar to many developers.

6.2 Understanding specification documents

In order to better understand and apply the two format specifications XJDF and PrintTalk as well as the three Interoperability Conformance Specifications Cus-APP ICS, CusQC and MisQC, the relevant basics of XML syntax should be explained, especially to beginners. The specification documents themselves also contain illustrative XML programming examples.

The XJDF and PrintTalk format specifications

A format specification is like a list of ingredients. It names, defines and explains all the elements and attributes needed to describe products and process steps in XJDF or commercial transactions in PrintTalk. According to the XML 1.0 standard, elements and attributes are color-coded and typographically encoded (italics, bold, uppercase) to make the structure of XML documents clearer.

Elements

Elements always describe structured data, such as *InkZoneCalculationParams* (calculation of ink zone presetting data) or *Layout* (coordinates on the printed sheet), but can themselves have unstructured features, such as *Comment* or *BundleItem* (specifying the essential quantities).

Only explicit product elements are called up by the print media buyer when creating a print product online. Just the MIS networked with the production systems adds explicit process elements or intentions, e. g. *ProcessRun* (process step details), *BindingIntent* (type of binding) and abstract elements (e. g. *Resources*), to the XJDF file after the order is received, resulting in a complete XJDF job ticket. PrintTalk links the XJDF document to purchase elements, such as *PurchaseOrder* or *Cancellation*.

Attributes

Attributes always occur in conjunction with elements by describing unstructured characteristics of the elements in more detail. Such characteristics are usually name-value pairs. Attributes appear as a *string*, beginning with @, which may take a numeric value or a restricted token (e. g. for a concrete process step) or, less frequently, specifies a comma-separated enumeration.

For example, the *BindingIntent* element can be characterized with the name-token pair *@BinderySignatureType*= "Fold", indicating the process of folding. The distribution and orientation of the folded sheet pages appear in the related element *BinderySignature* with the two attributes *@FoldCatalog* and *@BindingOrientation*. In Messaging (XJMF), the values are updated in the name-value pairs.

The Interoperability Conformance Specification (ICS)

In addition to the format specification, the 'list of ingredients', an Interoperability Conformance Specification is the 'recipe'. The ICS systematically summarizes all the ingredients (elements and attributes from the format specification) that are relevant for a specific application purpose, the 'dish', and defines the way in which they interact logically. In other words, a format specification describes the meaning of the individual elements and attributes, and the ICS assigns them their tasks. Tasks must be programmed in general in the interfaces so that they can be executed later in concrete terms on the basis of the job tickets that pass through them.

The interaction is divided between the so-called entities 'Manager' (central controller) and 'Worker' (all other instances of the value chain). Thus, manager and worker appear only in an ICS and not yet in the format specification. The manager is the source of the task and the recipient of feedback. Accordingly, a worker is the recipient of job data and the source of feedback. Thus, for example, in the Cus-APP ICS, the front end of the web-store used by the customer is the manager and the MIS (MIS/ERP, web-store back end) is the worker. By specifying certain relationship types—the so-called cardinality—for the manager and worker (see Table 9), the software and interface developer knows which logical steps and loops are permitted, required or prohibited.

For example, a manager cannot make a measured value entry in a measuring device. Conversely, no worker can write the setpoints required for this. In this context, a distinction is made between static and dynamic workers: static workers send XJMF messages without specifications, e. g., production speed, dynamic workers react with actual values in XJMF messages to setpoints of the manager, e. g., with color measurement values. More detailed explanations of the terms and their meaning, together with examples, are provided in the tables 10 and 11.

Notation	Quantity indication
Element or *Attribute*	SHALL occur exactly once.
Element ? or *Attribute* ?	MAY occur zero times or once. In the description field of the *element* or *attribute* some circumstances MAY be explained which, if fulfilled, SHALL, cause the *element* or *attribute* to occur exactly once.
Element +	SHALL occur once or several times.
Element *	Occurs zero or more times.

Table 9: Cardinality for finite sets of elements and attributes

Notation in the ICS	Interpretation: The element or attribute or its value…
w = Write Required	…SHALL be entered by the ***manager*** or the ***worker***.
w? = Write Optional	…MAY be entered by the ***manager*** or the ***worker***.
w← = Write Conditional	…SHALL be entered either by the ***manager*** or by the ***worker***, depending on the conditions. The details of the condition are specified in the description.
w! = Write Forbidden	…SHALL NOT be registered. (Thus, there is no cardinality reaction of the ***worker*** to the ***manager*** to be defined.)
r = Read Required	…SHALL be read by either the ***manager*** or the ***worker***.
r? = Read Optional	…MAY be read by either the ***manager*** or the ***worker***.
r← = Read Conditional	…SHALL be read by either the ***manager*** or the ***worker***, depending on the conditions. The details of the condition are specified in the description.

Table 10: ICS notations for describing the cardinality of the logical interaction between manager (central controller) and worker (other process interface).

Elements or attributes in the XJDF CusQC	Notation in the ICS		Interpretation of the logical handling
	Manager	Worker	
AuditResource (describes the use of resources during the execution of a process—here: Quality control—and thereby protocol-lates consumption and production quantities, e. g. sheets in the print run).	r	w	Quality reports SHALL be provided as *AuditResource* elements containing a *ResourceSet*[*@Name*="QualityControlResult"]. Multiple *AuditResource* elements containing different subsets of quality reports MAY be processed by the ***worker*** and SHALL be processed by the ***manager***. Additional, non-conformal *AuditResource* elements MAY exist, but are not within the scope of this ICS.
<all other audits> *<all other attributes>* *<all other values>*	w? r?	r? w?	Additional audit elements MAY be present, but are not within the scope of this ICS.
ResourceSet [*@Name*="Layout"] (names the data source where a description can be found—in the case of quality control the coordi-nates of the measure-ment patches on the print sheet)	w←	r←	A layout SHALL define the geometry of the measure-ment patches. The *ResourceSet*[*@Name*="Layout"] SHALL be provided if the receiving system is to au-tomatically find measurement patches on a compo-nent, e. g. a printed sheet, and SHALL NOT be provided for manually positioned quality measure-ment systems (e. g. handheld spectrophotometers).
@QualityMeasurement	w!	–	*@QualityMeasurement* MUST NOT be specified for the *QualityControlParams* (= setup of the quality control)

Table 11: ICS notation examples for the logical interaction of manager and worker.

XML-to-JSON mapping for the XJDF data type

The two format specifications XJDF 2 and PrintTalk 2 as well as the ICS alone do not yet enable programming of web and mobile applications. For this, a JSON mapping is required (i. e., the programming language translation of the XML code into JSON or JSON-LD). Work on this translation is largely complete, and an editor software tool is available. Registered users can obtain further information and participate in the development discussions and design from the CIP4 website. The quality of the translation is to be verified with a JSON schema. Reverse-mapping from JSON to XJDF or PrintTalk will also be possible.

While the JSON format is described by ISO/IEC 21778 [13], the XML-to-JSON mapping is not standardized. An introduction to the topic can be found by doing an Internet search using the terms 'XML JSON', such as a German-language site or an comparable English language article.

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[2] ISO 16684
Graphic technology—Extensible Metadata Platform (XMP)
Part 1: Data model, serialization and core properties
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Part 3: JavaScript Object Notation (JSON-LD) Serialization for Linked Data in XMP

[3] ISO 19445
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[4] ISO 21812
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Part 1: Architecture and basic requirements for metadata

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Part 1: Relationship to CxF3 (CxF/X)
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Part 4: Spot colour characterisation data (CxF/X-4)

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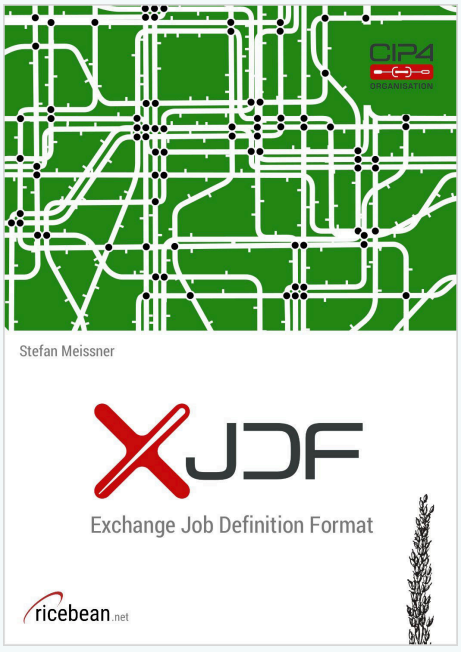
Getting started with the XJDF format specification

In his book 'XJDF—Exchange Job Definition Format', XJDF co-author Stefan Meissner provides access to the abstract format specification of XJDF through explanations and comments.

This English-language publication, aimed primarily at interface and software developers, covers the essentials of XJDF and is intended to enable its readers to work with the official XJDF specification. It provides a summary and explanation of the basic concepts and ideas behind XJDF.



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Glossary

API: Application Programming Interface

A program part that is made available by a software system to other programs for connection to the system.

Artificial intelligence (AI)

Branch of information technology whose goal is to automate intelligent behavior, i. e., to emulate human decision-making structures with the help of knowledge-based reasoning (expert systems) and/or independently evolving machine learning (deep learning, neural networks); a distinction is made between 'strong AI' (complex problem solving on a par with humans) and 'weak AI' (solving specific, narrowly defined tasks). Weak AI is already used, for example, in the rapid generation of gang forms or ↑CRM systems. Strong AI does not (yet) exist.

Attribute

↑XML-based syntactic construct that describes an unstructured feature of an ↑element. Such attributes are usually name-value pairs that are associated with elements. XML attribute types appear as strings, as a restricted token, or as an enumeration, and can be recognized by their link character @, e. g. *@Status*, *@ID* or *@ResourceID*.

Business Objects

In the PrintTalk format specification or in the ↑Cus-APP ICS for ↑XJDF, the part of an ↑XML file that describes business transactions between the print media buyer and the print service provider. In the Business Objects workflow, the duration of the transaction steps and the effect of objects on other objects are mapped, identities for process participants and processes are assigned or called up, and subsequent business processes (procurement, modification of the order, data delivery, invoicing, etc.) are triggered. The Cus-APP ICS for XJDF also triggers XJDF actions such as job tracking, in which ↑XJMF messages of the ↑Milestones are generated.

CIM: Computer-integrated Manufacturing

Manufacturing concept which includes other computer-aided concepts such as CAD (design), CNC (numerical control), CAQ (quality assurance) and PPC (production planning and control, including plant data acquisition and machine data collection, PDA/MDC).

CIP3: International Cooperation for the Integration of Prepress, Press and Postpress

Consortium of renowned international manufacturers, consultants and printers founded in 1995 on the initiative of Heidelberger Druckmaschinen AG, Kiel, with the aim of '↑CIM for Print' (computer-integrated manufacturing of print products); lead authors: Stefan Daun, Reinhard Koch, Dr. Jürgen Schönhut (Fraunhofer IGD, Darmstadt); format specifications: Print Production Format (still valid: ↑PPF 3.0), ↑PrintTalk; transferred to ↑CIP4 in 1999.

CIP4: International Cooperation for the Integration of Processes in Prepress, Press and Postpress

Successor to ↑CIP3 with the aim of advancing process automation in the printing industry—from design through prepress, conventional and digital printing processes to postpress—based upon ↑XML; lead authors: Dr. Rainer Prosi (Heidelberger Druckmaschinen, Kiel), Stefan Meissner (Cimpress, Munich); current format specifications: Job Definition Format ↑JDF 1.7, ↑PrintTalk 2.1 and Exchange Job Definition Format ↑XJDF 2.1.

Connectivity

The ability of a system to communicate unrestrictedly with other systems via interfaces; a prerequisite for ↑interoperability.

CRM: Customer Relationship Management

Function in ↑MIS/↑ERP solutions for customer management and bespoke customer targeting.

Cus-APP ICS for XJDF:
Customer to Automated Print Procurement ICS

↑ICS based on ↑XJDF and ↑PrintTalk 2 for automating transactions between print/finishing service providers and print media buyers. Specifies a standardized interface for handling the purchasing processes associated with the procurement of print media in real-time via the Internet (web-to-print).

CusQC: Customer to Quality Control ICS

↑ICS for communication of quality data between the ↑MIS/↑ERP and the connected production systems. Forms the ↑QC ICS together with the ↑MisQC.

CxF3: Color Exchange Format v3

Standard developed by X-Rite and described in the ISO 17972 series of standards for the exchange of color data together with the associated ↑metadata.

cXML: Commerce XML

Non-printing industry-specific ↑XML-↑vocabulary for business and commercial applications. Although cXML 1.2 served as a model for ↑CIP4 ↑PrintTalk, later PrintTalk 2.1 is based on ↑XJDF and uses pure standard XML.

Element

↑XML-based syntactic construct that describes structured data in ↑XJDF, but may itself have unstructured attributes, e. g. *Comment*, *BundleItem*, and *Resources*; ↑Attribute.

End-to-end communication

Passing digital information from one end of a communication chain to the other and back again without a media break. This means that communication can take place in real-time.

Entity

In data modeling, an unambiguously definable object about which information is to be stored or processed; such information objects can be things, acting persons, process sections and instances, or states.

ERP System: Enterprise Resource Planning System

A system for business planning that is used throughout the company or by customers and partners. The MES or print ↑MIS is subordinated to the ERP.

FMCG: Fast Moving Consumer Goods

Goods with a short shelf life, also known as consumer packaged goods

Ganging

Creating multiple-copy printing forms in which the individual blanks or subjects are not nested but follow a grid. The copies can thus be separated from each other with the help of a guillotine. For non-rectangular subjects, ↑nesting is often the more economical alternative (see Figure 14).

GDSN: Global Data Synchronization Network

International directory for article master data in the retail trade. In GDSN, all goods of the participating countries and manufacturers are uniquely registered with an alphanumeric code, the Global Trade Item Number (GTIN) — in the form of their preliminary and end products and variants as well as their shipping and sales sizes in pallets, transport and individual packaging. The GS1 ↑XML code is part of various EANCOM codes, including the EAN barcode, which is scanned at the supermarket checkout and enables the output of the sales price by linking it to the retailer's price database.

ICS: Interoperability Conformance Specification

Additional specification that combines elements of one or more overall specifications for a specific task, and specifies them with the parameters, properties and options that are specifically expected.

An ICS defines the logical interaction of the central controller (↑Manager) and the other instances (↑Worker) in the value chain. In addition, this avoids having to map irrelevant ↑JDF or ↑XJDF ↑elements, including irrelevant or even redundant data, at the process interfaces. Thus, a solution is only ever compatible with parts of JDF/XJDF. Software and interface developers can reach their goals faster and better with the help of clearly structured tools that allow systems and solutions to work together independently of manufacturers (↑interoperability).

Internet of Things, IoT

The vision of the all-encompassing digital networking of physical and virtual objects to create a global infrastructure. Examples from everyday life include a refrigerator that automatically reorders food or a heating system that can be controlled remotely via an app.

Interoperability

Ability of a system to cooperate with other systems by communicating via defined interfaces (↑connectivity), whereby the standardized method of cooperation is suitably specified in an ↑ICS.

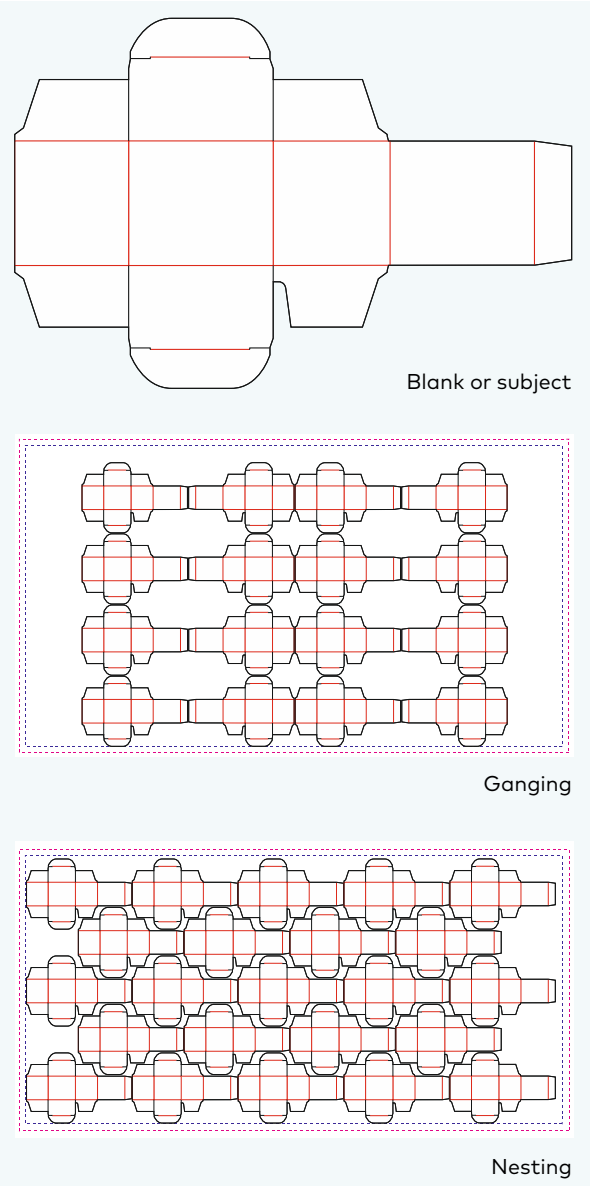

Figure 14: Ganging and Nesting

JDF: Job Definition Format

Industry standard published by ↑CIP4 in 2000 to simplify the exchange of information between users and systems in the printing industry. JDF enabled the integration of print MIS and technical workflow for the first time. The use of ↑XML was intended to enable maximum portability between different platforms and easy interaction with Internet-based systems.

JDF specifies in detail the entire production process: agency – media design – prepress – press – postpress – logistics. Combined with the ↑JMF response and message exchange protocol, it can be used for complete job tickets. Jobs can be planned and tracked, pre- and post-calculated in the print MIS. The print media buyer can be shown a product preview and the current production status (job tracking). Serial, parallel, cross-lap and iterative workflow

processes can be defined by users in any combination and across distributed locations.

Current versions:
JDF 1.7,
JDF 2.1 = ↑XJDF 2.1

JMF: Job Messaging Format

Sub-format (subset) of ↑JDF used to report status and availability of production systems: besides production progress (counted copies), these are the operating states ramping up, on/off, standby, ready, busy, done, waiting, and maintenance mode; see also ↑XJMF and ↑JDF for current versions.

JSON: (pronounced 'jason') JavaScript Object Notation

Human, and machine-readable data-exchange format that represents structured data in slim, easy-to-read text form (serialization). It is designed for use in particular in cloud applications and apps on mobile devices for transferring data between a client and a server. JSON can also be generated for data which are linked to each other via the Internet (JSON-LD: JSON Serialization for Linked Data).

JSON mapping

Translation of a program code to ↑JSON. In the case of XJDF-to-JSON mapping, the standard ↑XML is transferred from ↑XJDF to the standard JSON-LD, so that a complex XML becomes a serial readable JSON, because mobile apps from the cloud expect serialized data and not multi-line XML data trees. It is also possible to map ↑REST to JSON (see Zaikio on page 27).

Manager and Worker

Acting instances whose respective logical interaction when writing (↑notation w for write) and evaluating (notation r for read) ↑elements and ↑attributes is defined in an ↑ICS. The manager is the source of the instructions and the receiver of the feedback. Accordingly, a worker is the recipient of instructions and the source of feedback. with specific rights for reading and writing (required, optional, conditional, forbidden).

Metadata

Descriptive data which include information about a media file, such as creation date and software, author name, comments, etc., but also embedded XJDF job tickets.

Milestone

Describes the overall status of a print job in the ↑XJDF format specification and in the ↑Cus-APP ICS for XJDF by sending the respective status of completely processed processing steps as a ↑XJMF message to the print MIS. These milestones may then be utilized to provide the print media buyer with job tracking information that can be called up at any time. The live view of current counts is not a milestone.

MIS: Management Information System

1. In the printing industry, 'MIS' is often used to describe administration software that is applied to manage as many customer, purchasing and production processes as possible, including their planning and control. It is used to manage customer and order data, and to optimize production, warehousing and logistics processes, as well as personnel deployment, more or less flexibly by means of operating and machine data collection. In some cases, quality management is also integrated.

2. In other industries, a term for an analysis and reporting system for operational key figures (with financial accounting as the data source) to help management make decisions on strategic measures. The 'administration software' is usually referred to as a 'management execution system' (MES) or casually as a 'shop floor system', which operates on the 'floor of the production facility'. This distinguishes the MES from the ↑ERP system on the executive floor. In most cases, the 'print MIS' refers functionally to an MES.

3. In the ↑JDF and ↑XJDF specification, the 'top controller in a workflow'. It can be responsible for dictating and monitoring all workflow processes to be executed (print MIS or ERP system with integrated MES function) or only act as a controller module in a prepress workflow. For the interface function described in an XJDF ↑ICS, it is completely irrelevant how the 'MIS' is designed.

MisQC: MIS to Quality Control Device ICS

↑ICS for communication of quality data between the ↑MIS/↑ERP and the connected production systems. Forms the ↑QC ICS together with the ↑CusQC.

Namespace

A namespace is used to uniquely identify ↑elements and ↑attributes in an ↑XML document, to validate them with a schema, and to mix multiple XML languages in a single document. The function of a namespace can be compared to the prefix of a telephone number.

Nesting

Creating multiple-copy printing forms in which the individual, arbitrarily contoured objects are arranged interleaved within each other to save space (as opposed to ↑Ganging); can also involve creating punching and laser cutting contours. Objects can thus be separated from each other only by punching and breakout. Examples: folding boxes, labels; see also Figure 14.

Notation

Logical description of how ↑attributes or ↑elements should interact in a process.

OPC UA:
Open Platform Communications—Unified Architecture

Standardized machine networking format outside the printing industry according to IEC 62541, which uses non-↑XML technologies and is based on standard Internet network protocols (TCP/IP port, SOAP with Java and .NET). OPC UA is not human-readable, but it describes machine data semantically. OPC UA networks systems that output unchanging products (mass production). The printing industry, on the other hand, has with ↑JDF and ↑XJDF a strong possibility for a changeable job-related product description beyond process networking. Through HTTPS XML mapping and verification with the OPC Binary XML Schema, OPC UA can become compatible with JDF/XJDF.

PHP: Personal Home Page Tools, meaning changed to Hypertext Pre-Processor

Open-source scripting language with C- and Perl-related syntax; strengths are database support under various Internet protocols and the availability of numerous function libraries. Current version: PHP 7.x.

PPF: Print Production Format

File format developed in 1995 by ↑CIP3 that generates the presetting commands for format and ink zone control elements on offset presses and for folding elements and cut-off sequences in postpress from the PostScript file on the RIP (later also from the PDF print file). The ink zone profiles on the offset press could be visualized on the control console monitor as a printing-form preview and ink-zone diagram. PPF in its latest version 3.0+1a can still be used in ↑JDF/↑XJDF.

PrintTalk

An ↑XML ↑vocabulary (originally based only on ↑cXML for business and commercial applications), created by the NPES PrintTalk Community (e-commerce companies, ↑MIS developers, printers, press manufacturers); further developed from 2004 by ↑CIP4; now upgraded to the ↑XJDF data model and cXML 1.2 and thus standardized XML format for communication of business data and transactions between print service providers and with print media suppliers.

PrintTalk 2.x harmonizes with XJDF 2.x. The interaction of the two specifications is described in the XJDF Customer to Automated Print Procurement ICS (↑CusAPP ICS) and the Customer to Quality Control ICS (↑CusQC), whereby the CusQC can also represent functioning processes without PrintTalk. Since XJDF and PrintTalk now use the same data model (standard XML), a PrintTalk file (↑namespace: PTK) can also be used with the XJDF namespace. This now also allows mapping to ↑JSON, which expects pure XML.

Private data

Proprietary data which can initially only be written and read by the solution provider who programmed the considered interface. Even ↑elements in individual ↑XML dialects are 'private data', since they deviate from the general XML jargon or from the unambiguous ↑JDF ↑vocabulary and are thus not readily understood by other systems. To enable networking with third-party systems, the considered dialect must be agreed individually between the contracting parties in each case.

Procurement

Operational purchase of services or goods; 'print procurement' is therefore the purchase of print media. The digital version is called 'e-procurement' and covers all commercial processes (purchasing of materials and services, quotation calculation, invoicing, financial transactions) via the Internet (online stores) and associated ↑MIS/↑ERP systems. The XJDF Customer to Automated Print Procurement ICS (↑Cus-APP ICS) is an interoperability and programming tool for implementing and automating such processes under ↑XJDF.

QC ICS: Quality Control ICS

↑ICS for the automated internal and external exchange of quality data. Consists of the parts ↑CusQC for the interface between customer and ↑MIS/↑ERP and ↑MisQC for the interface between MIS/ERP and the connected production systems. This makes it possible to communicate quality requirements specified by the customer to the production systems via the MIS/ERP and to report quality data supplied by the measuring devices and sensors (selectively and, if necessary, aggregated) back to the customer.

REST: Representational State Transfer

Programming style that links a www-style client-server architecture and that many ↑MIS/↑ERP solutions use successfully. The application programming interface (REST ↑API) uses protocol, browser, and language standards and accordingly existing HTTP, HTML and XML infrastructures. However, this does not mean that REST itself embodies a structured data model (like ↑XJDF), but rather that it describes—just like ↑XML—only a formatting of data. Thus, two applications that both provide a REST API are far from being able to communicate with each other in a meaningful way.

Vocabulary

A number of ↑XML elements that are defined specifically for a particular application or specification and are not part of standard XML.

Well-formed and valid

'Well-formed' is a code if it is in pure, dialect-free syntax; 'valid' is the code if its structure is verifiable with a formal schema. Therefore, for each ↑XML-based ↑CIP4 specification, the relevant XML schema (.xsd) is also provided.

Worker

↑Manager and Worker

XJDF: Exchange Job Definition Format

Exchange format for the printing industry that can communicate with the 'rest of the world' through pure ↑XML 1.0. XJDF 2.x is the simplified redesign of ↑JDF 1.x. Whereas JDF was based on the idea of a complete electronic job ticket, XJDF assumes that the job ticket is represented only internally in an administrative application (print ↑MIS, controller, prepress workflow system), but is not limited to it. XJDF describes the interface between management and production applications (executing applications) and is thus designed as a pure information exchange interface. This leads to significantly reduced complexity and faster processing compared to the original JDF design.

Current version: XJDF 2.1.

XJMF: Exchange Job Messaging Format

Sub-format (subset) of ↑XJDF, which—in addition to the earlier ↑JMF functionality of ↑JDF 1.x—is used to report quality data of all kinds. XJDF queries are answered in real-time, provided that the corresponding measurement data are collected inline and permanently.

XML: eXtensible Markup Language

Most widely used and both human- and machine-readable markup and meta language for structured documents; ↑XJDF 2.x and ↑PrintTalk 2.x use standardized XML 1.0 as well as ↑'well-formed' and 'valid' XML. All XML data are identified by the ↑namespace xmlns= which links to the URL of the relevant XML schema resource depending on the 'preference' (↑XJDF, ↑XJMF, ↑JDF or PTK for ↑PrintTalk) so that all four languages can be used within the same XML file.

XMP: Extensible Metadata Platform

Standard (ISO 16684-1) for embedding or attaching (as a filial file) ↑metadata in media files such as TIFF or PDF; ISO 19445 additionally describes the transport of status and release information as XMP metadata in PDF/X files; XMP is the prerequisite for embedding ↑XJDF job tickets in PDF/X-6 (ISO 21812-1).

Imprint

XJDF—Building Block for the 'Printing Industry 4.0'
Whitepaper

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