Remote Contract Proofing

William J. Hulsman and A. Stephen Novick
E.I. DuPont de Nemours and Co., Inc.
Wilmington, Delaware

Abstract

With today's time to market pressure, there is a need for remote contract proofing. Remote contract proofing is remote printing with a twist, Certification. Certification is the quantification of the actual color of the ink on paper. We discuss the need for color consistency, accurate and repeatable measurement. The issues and results surrounding accuracy and repeatability of various measurement instruments and proofing devices are explained. Alternative issues of what colors to measure, how to integrate the measurement into the workflow, and how to represent variances are explained. Several examples are given, with cost-benefit analysis where practical. Outstanding issues of color science are discussed. Measurement and the effect on overall system performance are covered in depth.

There is a great need for timely communication of color quality to various team/project members. The solutions involve both the obvious digital network for transporting the image (fat pipe) and the network and database transporting and storing the meta-data gathered at image transport, image proof, and image certification (thin pipe). Database issues are discussed along with various choices for implementation along with the relative costs. Network reliability issues are discussed, as are factors such as scalability, bandwidth and access.

The time has come for remote proofing. Networks, databases, and proofers are capable due to "Moores Law". However there are still outstanding issues in the color science area and system configuration to optimize results.

Introduction

Remote Proofing is defined as moving digital Color Proof information from location to location in a way that ensures file and color integrity. Remote Contract Proofing is achieved if you're doing this at a level of quality and consistency that allows you to "trust" the remote proof enough.

The goal of a contract proofing system is to produce a reasonable representation of the printed job so the customer can determine if any modifications are needed before the press run. The proof, once approved, guides the pressmen as he/she sets up the press.

When multiple contract proofs are used at multiple locations to make color appraisals, it is critical that each proof is the same. To achieve "sameness", accurate color profiles and color modeling are required along with stable proofer behavior and very little image color degradation over time. The DuPont Cromalin™ Digital system has been developed so that the proofer is quite stable and image color degradation is minimized.

It is economically desirable to be able to use the printed image from a common drop on demand proofer as a contract proof. However, the attributes of a color image in the small office/home office market are quite different from contract proofing. Printer stability is not nearly as important, nor is color stability. Therefore it is no surprise that the results of our color testing of many common drop on demand printers utilizing dye-based ink show proof to proof variation on the order of 5 delta E and color fading on the order of 10 delta E over a short time period. This renders these types of systems difficult to use as contract proofers.

Fortunately, drop on demand printers that utilize pigment based inks or specially formulated ink/media combinations show significant improvement in color stability, and may soon be stable enough to provide a candidate contract proof.

Workflow

In order to best utilize their resources, customers commonly spread work over many distant locations. Improving color communication between these locations is required to reduce cycle time and color risk. This is the main goal of remote contract proofing.

The typical workflow requires some initial set-up. This consists of:

- Determining the possible senders and receivers
- Defining the high bandwidth image network between the sender and the receiver
- Configuration and access to the Certification and Job tracking database
- Definition of color matches
- Agreement of color tolerance thresholds
- Definition of patch receipes on the iCertification strip

The steps required to send a remote proof from the sender location are as follows:

- Select the image or images to proof
- Select the receiver location(s)
- Select the color match that should be applied to the image
- Send the job

The job will be sent and the status will be logged in the Certification and Job tracking database.

At the receiver location the receiver is pre-configured to either proof or "hold" images for eventual proofing. When the proof is enabled and printed a CRT resolution image is posted in the database and the job status is updated.

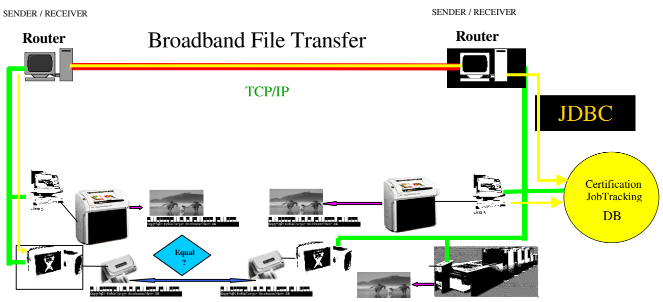

Figure 1. Typical Configuration

The iCertification strip is measured and compared to the expected color results. Status is updated to the database. Optionally a label can be printed locally to document the measured color quality of the proof.

At this time interested parties can work together on this image by viewing the printed color accurate image and annotating the CRT resolution image.

Customer Expectations

Customers traditionally communicate color to multiple locations by simply making multiple copies of an image (usually on the same proofer), visually inspecting all images (usually by the same person) and shipping the proofs to all viewing locations.

Remote proofing shortens the traditional process by removing the need to ship a physical proof. Collaboration is more efficient with CRT resolution images to view at all locations. Remote printing is more efficient when the customer can repurpose "transferred" data for a remote press run.

Remote proofing adds the following complexities versus the traditional workflow:
- Each image is made on a different calibrated proofer
- Each proofer is calibrated with a different spectrophotometer
- There is a network transfer required
- Since the images never physically exist at the same location, instrument based quality checks must be used rather then manual visual checks

The customer expects shorter cycle time and improved color communication while maintaining the same color control as he or she had when making multiple copies and shipping them to the remote site(s).

This requires the assurance of total system stability. All proofs should vary less then an agreed color match threshold. Waste should be minimized. All color performance metrics measured should be available for interested parties.

System Foundation

Color Measurement Instrumentation

Ideally measuring color would be repeatable, accurate and precise. The results of a simple experiment illustrate the state of today's measuring devices. In our laboratory we assembled three calibrated measuring instruments. Each instrument was a different model, 2 of the three from a single manufacturer. We measured 13 tiles, 4 times with each instrument to get an average reading per tile per instrument and then compared the readings between instrument models. Instrument to instrument variations average 0.8 delta E. Variations as high 2.7 delta E were observed between instruments from different manufacturers. Variations as high as 1.1 delta E were observed between instruments from the same manufacturer. Average variations of 0.4 delta E were observed between successive readings with the same instrument, with maximum variations of 1 delta E. This simple experiment was conducted on tiles in a laboratory where the conditions were constant. Customer conditions are less ideal.

The most selective customers are critical to any visible color variation from proof to proof. Visible variations may only measure less then 1 delta E. Therefore these customers require much care in the selection of spectrophotometers to be used within their systems. Still color mismatches will sometimes be observed.

Color Modeling

Color models must be properly managed to insure transportability. We have had the most success when all aspects of the color manager are controlled.

This includes:
- Characterization files with known, appropriate and consistent sampling
- Color transformation models (link profiles) of known, appropriate and consistent size
- Consistent under color removal/black generation methods
- Spectrophotometers "corrected" to produce similar results
- Agreed mechanisms for capturing, storing and applying customer edits
- Clear user interfaces for easy match identification and selection

Networking

With the improvements in the digital world, the "fat pipe" used to deliver the actual image data from sender to receiver is less of a problem. There are many solutions that have bandwidths of 500K bits/second or greater. Among these are multiple ISDN,T1, T3, DSL and even cable modem arrangements. As competition and demand in this area increases from forces outside the printing and publishing world, costs and general availability decrease. The transport layer is invariably IP and the network can be either a publicly accessible WAN or private Intranet. The choices in the area of meta information that is carried in the "thin pipe". There is an extra challenge due to the desire to share this data between different corporations. The solution that we have used is standards based XML data description on top of the HTTP protocol. This has the advantage of being able to be used anywhere one can launch an internet browser. As long as the data store is "on the net" accessible to a browser (with the proper security credentials), the data is accessible to users in different LANS, WANS, etc. as long as they have "net access". "Plumbing" is no longer a major issue, just connect in the exact manner as a browser, transfer the request and get a result for that request.

Database

We have implemented a data base that stores Jobs, Spreads, Images, Users, Proofers, Groups, Companies, and Associations (groups of users and proofers .. maybe from different companies) in a relational database. Users are only allowed access to data when they have proper access privileges. The user first signs on with a password, and selects the Job, Spread, Proofer, etc of interest. Certification data are stored at reading time and retrieved via any browser in form reports. Standards based data access (JDBC) and query language (SQL) are used. The data are reduced to the metaphor of a familiar traffic light. Green for go, Yellow for warning, and Red for an out of limit situation. Green and Yellow signify "certified" with Yellow being a warning of a possible undesirable trend. Other reports are available as to trends for specific proofers or sites. The data are stored online until explicitly deleted when the Job is finished and individual data are no longer needed. Reduced data (averages, min/max etc.) are kept. With the standard SQL language it is possible to design "ad hoc" queries that will look at stored data in ways not anticipated at design time.

Present State

It is now possible with Dupont's iCertification process to achieve color proofs that are within 2 delta E of one another. This is achieved by controlling all color modeling parameters and outputting the proofs on very stable Cromalin™ Digital Proofers.

Communication of color performance is easily achieved through connections to an access controlled database.

Images are transferred typically over dedicated high band width lines from proofer to proofer. Measurement and descriptive data for each image are communicated via standard internet connections.

Conclusion

Color measurement instrumentation will improve so that there is less variation from instrument to instrument and manufacturer to manufacturer. At the same time the cost of instrumentation will decrease making them more available to low volume customers.

The capital cost of proofing devices will decrease significantly, making it more feasible to place proofers at many remote locations.

Common network bandwidths will continue to increase, while access cost decreases, making it easier to transfer large images over the general internet for a low cost.

At the same time workflows will become better understood and software tools, such as remote proofing, will be improved and expanded so that networks of customers can enjoy the reduced cycle time and cost afforded by new foundation technologies.

References

1. Michael H. Bruno, Principles of Color Proofing, Gama Communications, Salem, New Hampshire, 1986.
2. Hiroshi Maruyama, et al, XML and Java, Addison-Wesley, Reading, MA., 2000.
3. Didier Martin,et al, Professional XML, Wrox Press Ltd., Birmingham, UK 200

Biographies

William Hulsman

Bill holds a Bachelors degree in Electrical and Biomedical Engineering from Duke University and a Masters Degree in Engineering Management from the University of Massachusetts. He has specialized in developing, commercializing and supporting software products that have significant color and imaging technology components. Bill presently holds the title of software development manager within DuPont iTechnologies and is responsible for all DuPont software development activities for continuous flow inkjet systems.

A. Stephen Novick

Steve has architected electronic imaging devices and systems since 1983 starting with the world's first high resolution X-Ray scanner and Teleradiography System. For the past 10 years he has developed the DuPont 4Cast, Digital WaterProof and Digital Cromalin systems, most recently solving issues relating to remote proofing. He has a BSME from Stevens Institute of Technology, and is a Registered Engineer in Pennsylvania and Delaware.