Developing a Secure Network 3D Printing Protocol

Introduction

Additive Manufacturing, commonly called "3D Printing", is class of technologies that create three-dimensional objects by layering one or more materials. 3D Printing continues to grow in popularity, with wider ranges of products and a greater use of networking. However, recent reports from NIST (NISTIR 8023) show how important it is to secure network printers and to use secure protocols when communicating with them.

The Printer Working Group (PWG) developed the Internet Printing Protocol (IPP) with the Internet Engineering Task Force (IETF) in the late 1990's and early 2000's, developed an abstract Semantic Model of the IPP in the early 2000's, and continues to develop IPP, the Semantic Model, and related standards for network printers. IPP provides a concrete security model and uses TLS to provide a secure, confidential communications channel with the printer.

The focus of IPP and the PWG Semantic Model has been on traditional (2D) printers and services, however the same protocol and model can be used with 3D printers.

Adapting IPP and the Semantic Model for 3D Printing

The key differences between 2D and 3D printing are the materials used to produce the output and that the output is a stack of printed pages versus a 3D object. Materials can be defined using characteristics: color, diameter (for filament materials), guidelines (feed rate, retraction, speed, temperature, etc.), name, and type (pla vs. abs, etc.) Similarly, printer capabilities can be defined that allow the print client to produce output suitable for the printer without asking the user to manually enter dozens or hundreds of values.

Longer term 3D printers may also be able to provide onboard layer generation from higher-level formats such as Additive Manufacturing Format (AMF) and Standard Tessellation Language (STL). Again, both IPP and the Semantic Model can provide the necessary job ticket and printer capability information to allow the print client to take full advantage of this.

Why Use a Standard Protocol?

Using a standard protocol offers many advantages. First and foremost, standard protocols have been through extensive review and have demonstrated interoperability. In the case of IPP, billions of clients and printers use the protocol to produce about 115 billion printed pages each year. Those print clients run a wide variety of operating

systems and application software catering to their respective markets, but leverage IPP as the common language for talking to any printer.

Standard protocols also tend to produce better security features. For example, IPP supports TLS encryption, authentication using several different methods, document and job passwords, and release printing where you physically authenticate at the printer before anything is printed. IPP also does not provide a way for a client to directly access or control the printer hardware, making it unlikely that an attacker would be able to damage the printer or people around it.

Standard protocols like IPP also support remote monitoring of the printer and print jobs by any client software that supports the protocol. Often this is used to allow an operator to monitor the state of multiple printers from different manufacturers using a single client application. And of course the user doing the print job wants to know if there are any problems during printing and when the print is complete.

Finally, standard protocols have multiple implementations that meet the needs of a diverse set of applications and hardware and enable fast prototyping and development. IPP has many implementations including the open source CUPS software, which provides both client and server APIs along with an example IPP server program that can be easily adapted for use on a printer.

Next Steps

The PWG would like to define the necessary extensions to IPP and the Semantic Model to support 3D printing, but we need your help. The PWG invites all interested parties to participate in discussions on the PWG's 3d-printing list, along with Birds of a Feather sessions at face-to-face meetings, to help determine which extensions are needed and to ultimately define 3D printing over IPP.

PWG Web site: http://www.pwg.org

3d-printing list: https://www.pwg.org/mailman/listinfo/3d-printing