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Google Open Source

ChromiumOS Printing Update

Printer Working Group F2F May 2022

Agenda

- Review of ChromiumOS
- Projects used in Printing
- Features in Chromium
- Improvements since last year
- New Project: OAuth 2 for IPP

What is ChromiumOS?

- Google's Open Source operating system for Chromebooks (and other devices)
    - Approximately the same as ChromeOS minus some Google-only parts
- Gentoo derivative
    - Everything is built from source
- Supports a variety of ARM and x86-64 architectures
- Code available at chromium.googlesource.com

Open Source Projects in ChromiumOS

- CUPS
  - Print spooling
  - Driverless support
- cups-filters
  - gstoraster
  - pdftops
  - foomatic-rip
- Ghostscript

- sane-airscan: Mopria eSCL scanning
- SANE
- avahi + nss-mdns: mDNS resolution
- ippusb_bridge: local IPP-USB sockets

Features in Chromium

- mDNS detection
- Driverless support
- Matching printers with PPDs
- IPP-USB through local (UNIX domain) sockets

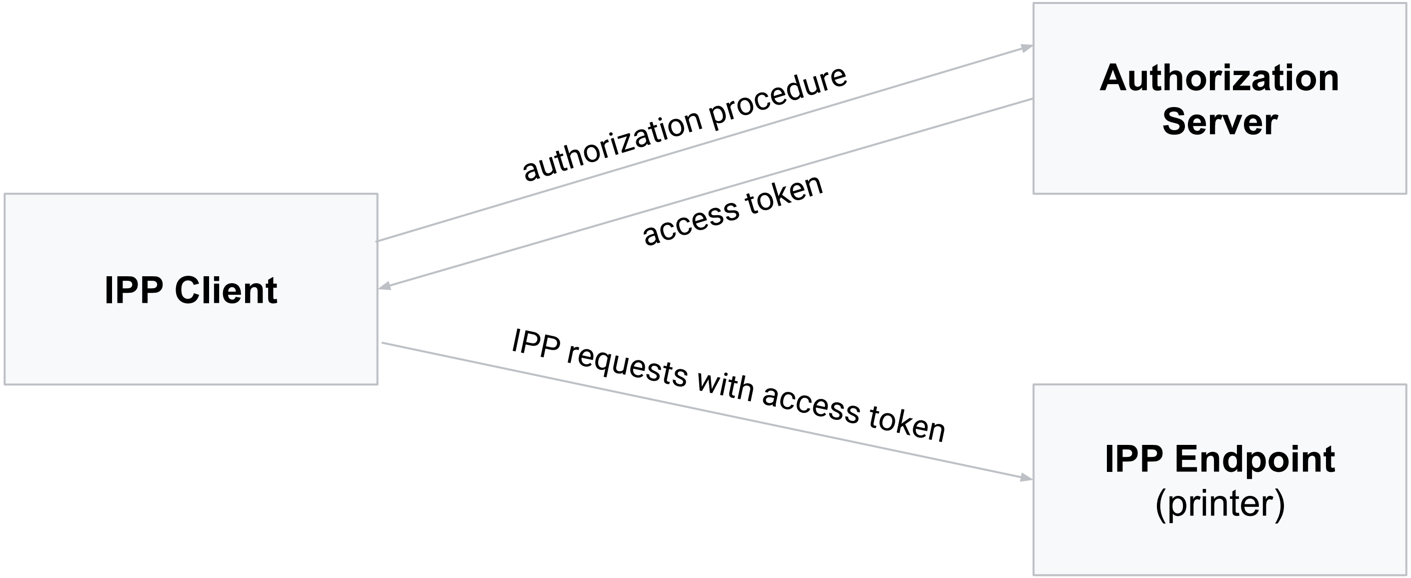
Recent Improvements

- General scalability of existing features
  - More PPDs available
  - More manufacturer-specific PPD keywords supported
  - More automated testing
  - Mock printer improvements
- Better sharing of USB devices between printing and scanning
- New feature: OAuth for IPP

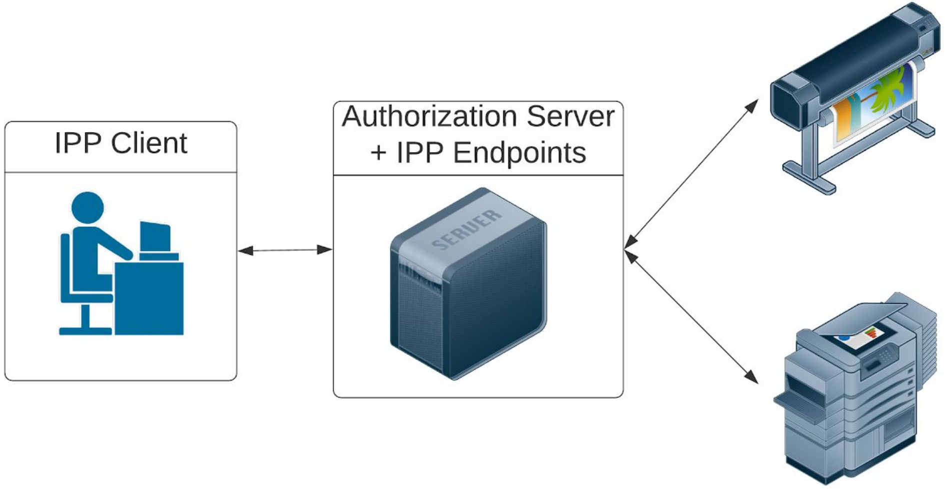
OAuth 2 for IPP

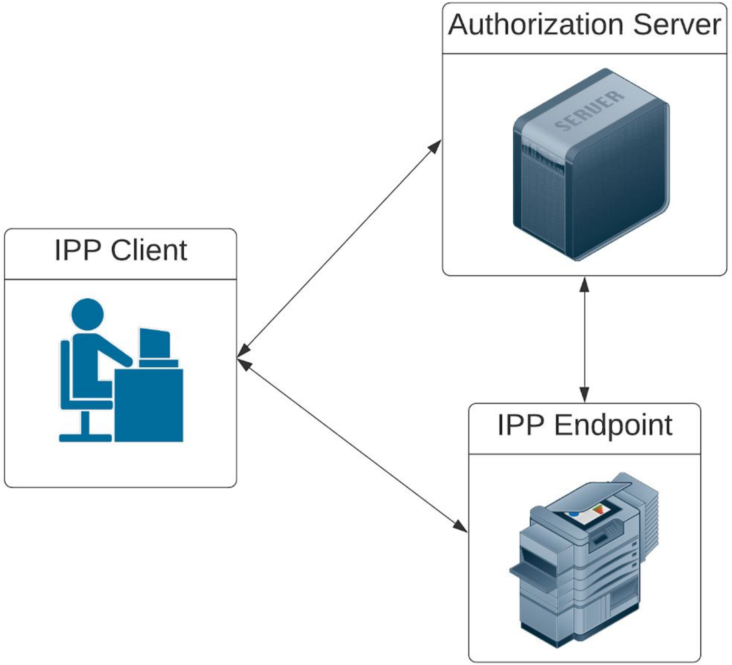
1. Scope of the project
2. Security considerations
3. Proposed protocol
4. Project status & proposed changes

General idea



Possible configurations





Main Assumptions

- **IPP Endpoint** can be managed by only one **Authorization Server**
- **IPP Endpoint** knows the URL of its **Authorization Server**
- **IPP Client** does not need any prior knowledge about the implementation of **IPP Endpoint** or **Authorization Server**
- **IPP Endpoint** does not need any prior knowledge about the implementation of **IPP Client**
- All communication between **IPP Client** and **IPP Endpoint** and between **IPP Client** and **Authorization Server** relies on https protocol

Out of Scope

- Communication between **IPP Endpoint** and **Authorization Server**
    - Verification of the access token performed by **IPP Endpoint**
- Capabilities of **IPP Endpoint** and the way jobs are processed
    - IPP version supported by **IPP Endpoint**
    - Printing pipeline - filters needed to process the document
- Source of knowledge of **IPP Endpoints**
    - Provided by user
    - Queried from **Authorization Server** or printing server
    - Discovered via mDNS

Security considerations

1. Communication between **IPP Client** and **IPP Endpoint** cannot be intercepted by any third party.
   The immediate goal: to protect user data.

2. Access to **IPP Endpoint** can be restricted to a limited set of authorized users.
   The immediate goal: to protect printer resources (e.g., paper, ink, printing time, etc.).

The second condition may be achieved only if the first requirement is fulfilled. Otherwise, attackers would be able to intercept credentials/access tokens and impersonate authorized users.

Mitigating possible attacks - fake **Authorization Server**

Both requirements must be fulfilled:

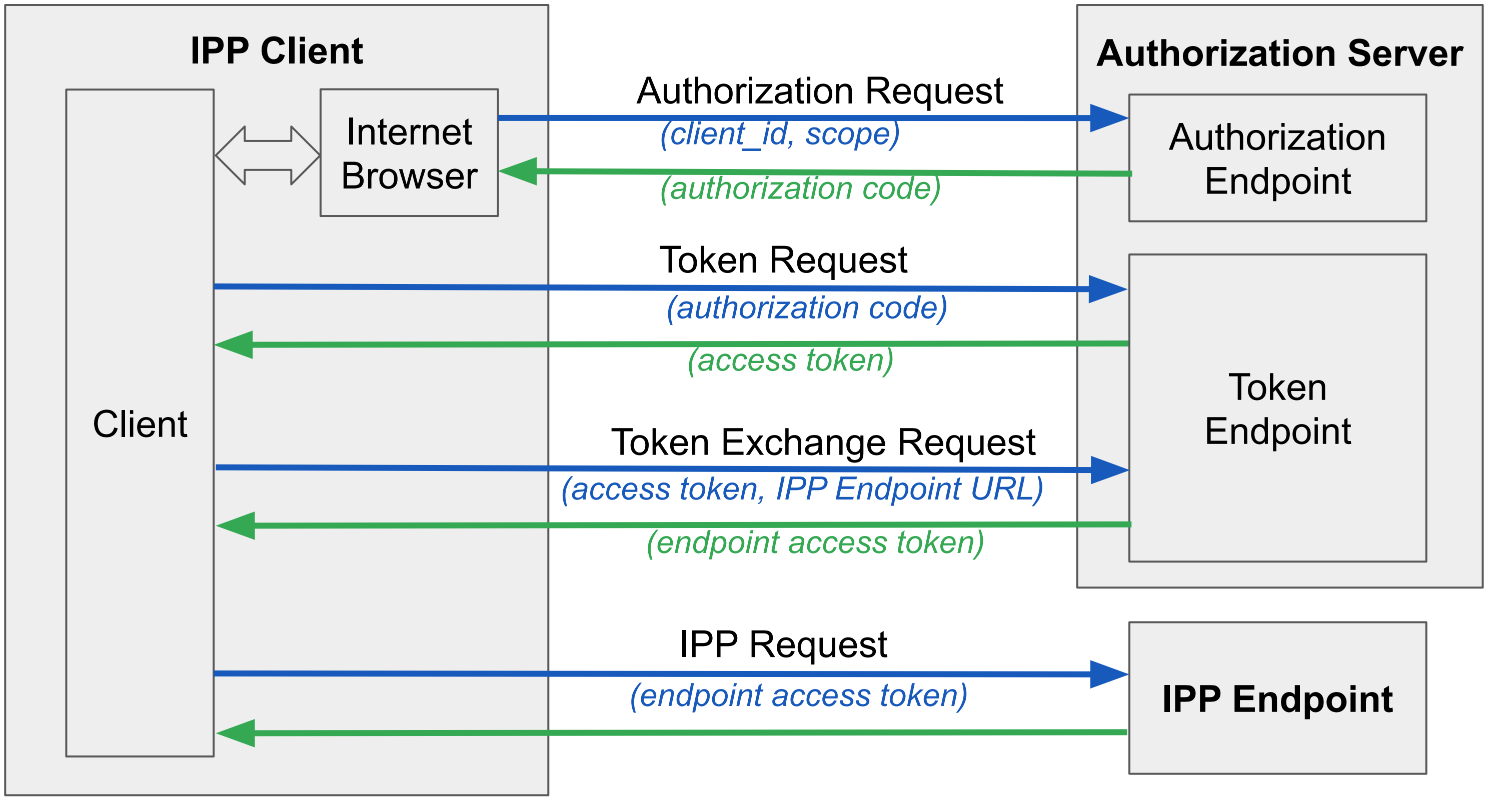
1. **Authorization Server** must have a valid certificate that is fully verified by the **IPP Client**
2. The URL of the **Authorization Server** must be trusted
    - Possible sources of **Authorization Server** URLs:
        - Well-known FQDN of the service
        - Provided by the administrator of the system/local network
        - Provided by the user
        - Provided by the **IPP Endpoint**
            - Must be explicitly verified by the user!

Mitigating possible attacks - fake IPP Endpoint

Both requirements must be fulfilled:

1. **IPP Endpoint** must have a valid certificate that is fully verified by the **IPP Client**
2. The **Authorization Server** must verify the identity of the **IPP Endpoint**
    - Possible approaches to identity verification
        - **IPP Endpoint** has FQDN that can be verified by the **Authorization Server**
        - **Authorization Server** verifies the fingerprint of the **IPP Endpoint**'s certificate
            - An alternative for printers visible only in local network and without unique addresses (e.g., discovered via mDNS)

Proposed protocol



Proposed protocol

1. **IPP Endpoint** managed by **Authorization Server** MUST return attributes:
   a. *oauth-authorization-server-uri* (always)
   b. *oauth-authorization-scope* (if needed).

2. **IPP Client** MUST:
   a. check that *oauth-authorization-server-uri* is on the list of trusted servers
   b. query metadata from the **Authorization Server** as described in RFC 8414
   c. try to register as a new client as described in RFC 7591 when:
      i. *client_id* is not known, AND
      ii. the **Authorization Server** allows for dynamic registration of new clients.

Proposed protocol

1. **IPP Client** MUST open session with **Authorization Server** as described in RFC 6749:
   a. the **IPP Client** uses an internet browser to open authorization link from **Authorization Server** and enables the user to complete authentication procedure provided by the server;
   b. the **IPP Client** obtains *access token* (and, if provided, *refresh token*) from the **Authorization Server**

2. The **IPP Client** uses *access token* to obtain *endpoint access token* for specific **IPP Endpoint** as described in RFC 8693
   a. the **IPP Client** sends to the **Authorization Server** the URL of the **IPP Endpoint** and the fingerprint of its certificate

Implementation Plans

- **IPP Client** in ChromeOS
  - experimental feature
  - activated by a flag
- Convince our partners to implement **Authorization Server** on their side
  - centralized solutions with infrastructure printers
- Future: stand-alone **Authorization Server** working with **IPP Endpoints** being:
  - print server - requires protocol between **IPP Endpoint** and **Authorization Server**
  - stand-alone printer - as above + OEM that agree to implement the protocols

Proposed changes

- **IPP Endpoint** should announce *oauth-authorization-server-uri* and *-scope* in HTTP header
  - Access to Get-Printer-Attributes request can be restricted too
  - Get-Printer-Attributes may be used to conduct DDOS attack
- Provide standard way of querying list of **IPP Endpoints** from the **Authorization Server**
  - It may be useful for some configurations
- **IPP Client** should be able to delegate to **Authorization Server** verification of a certificate of **IPP Endpoint**
  - **IPP Client** would not need additional configuration to verify **IPP Endpoint's** certificate

Thank you!

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