Making the ultimate print server for fun, profit, and open source sustainability

Opportunity Open Source Conference, 2024

Who am I

ValdikSS (or just Val)

- Linux user since 2008
- (former) Security expert
- (former) Reverse engineer
- Internet censorship researcher
- Amateur software developer

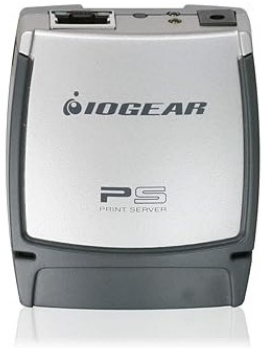
Bought a “new” printer

- Model from year 2002
- USB
- Very cheap ($5-$20)
- No 64-bit drivers
  *Obsolete **and unsupported***

Canon LBP-1120

How do I print from the phone?

I need a print server!



IOGEAR 1-Port USB 2.0 Print Server, GPSU21

★★★★☆ 1,451

#1 Best Seller in Computer Networking Print Servers

$42.99

$25.53 shipping

Xiiaozet Wireless Print Server Supports up to 3 USB Devices over Local Network, Share Printer or Scanner with USB2.0 Easy Setup, with Wired or Wi…

$79.99

X-MEDIA XM-PS110U 1-Port 10/100Mbps Fast Ethernet USB Print Server, USB 2.0 Port Network Print Server

★★★★☆ 81

$47.99

WAVLINK USB Wireless Print Server, Print Server with 10/100Mbps LAN/ Bridge, 480Mbps USB2.0, Support Wired/Wireles…

★★★★☆ 87

$49.99

ASHATA USB 2.0 Network Print Server, LAN Print Share Server for USB Printers, Print Server with Type C Power Supply, f…

★★★★☆ 4

$39.89

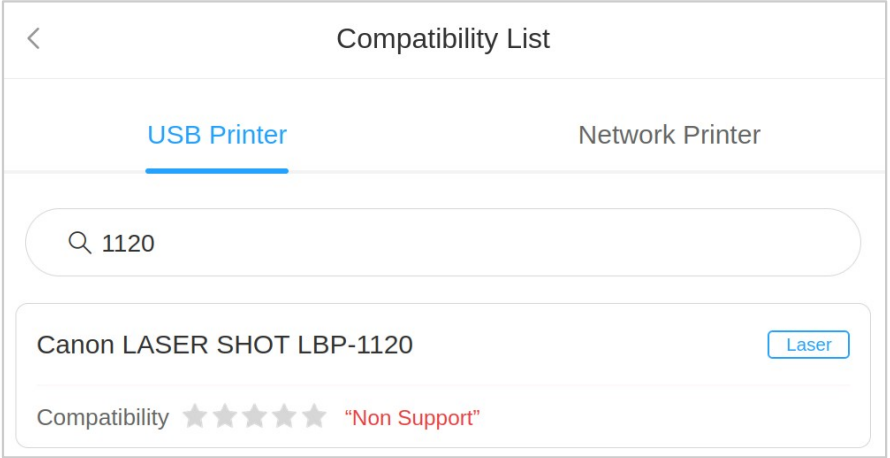
Retail print servers

Existing “dumb” print servers are just port forwarding devices from 2000s

- Printing, rarely scanning
- Requires driver on the PC, special app on iOS/Android
- Manual configuration, no autodiscovery
- Not what the user wants

But could I use it?

Canon LBP series is **unsupported**!



How do modern printers work?

- **Autodiscovery using mDNS + DNS-SD**
  No need to add the printer by IP address manually
- **Universal printing protocol**
  Internet Printing Protocol (IPP), based on HTTP
  Network-supported from the start
- **Universal printing language standard**
  Driverless printing, no app required
- **Unified printing formats**
  PDF, PWG Raster, Apple Raster, JPEG
- **Universally supported**
  iOS, Android, macOS, Linux, Windows

Driverless printing

mopria®

Print. Scan. Go.™

≈Interchangeable!

Works with Apple AirPrint

DIY print server

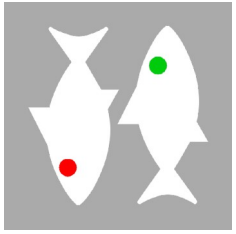
Let’s make our own print server! Software

CUPS

Printing server on Linux, with AirPrint/Mopria sharing support

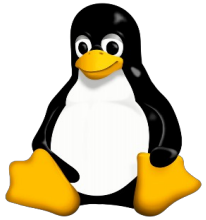
Fast x86 → ARM emulator with JIT, for x86-only drivers

Scanning server on Linux



AirSane

AirPrint/Mopria scanner sharing support

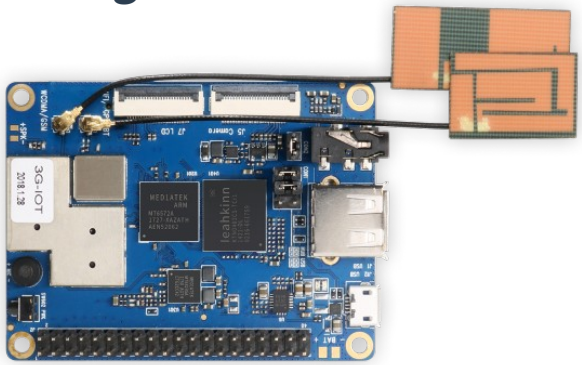


Linux

Of course!

Let’s make our own print server! Hardware

Orange Pi 3G-IoT-A



WiFi

Bluetooth

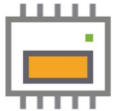
Multiple operating systems

TF card

USB 2.0

40pin headers

CSI camera port



512MB EMMC Flash

Size	51.5 mm × 69 mm
Weight	25 g
CPU	Mediatek MT6572M ARMv7 Cortex-A7 Dual Core, 1 GHz
RAM	256 MiB DDR2
Flash memory	512 MiB NAND
USB	1× USB 2.0 Host for printer 1× USB 2.0 MicroUSB for 5V power
Wi-Fi	802.11n 2.4 GHz
Audio! Microphone! Display and camera connections! And even 3G connectivity!	

$8? How could it be so cheap?

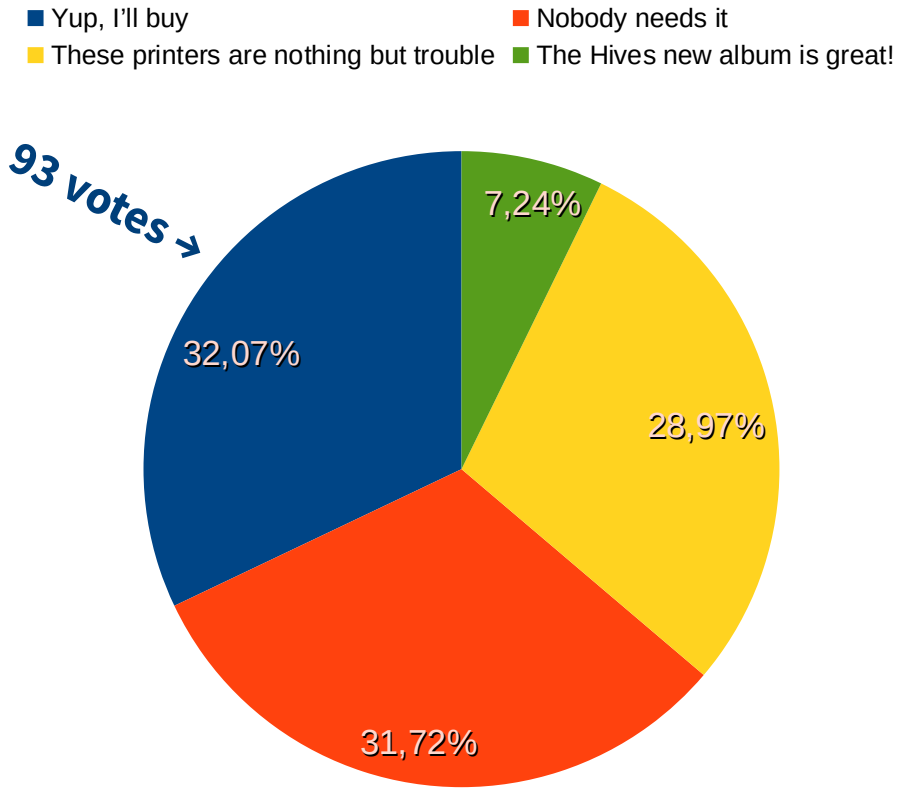
NO WORKING SOFTWARE

From DIY to retail

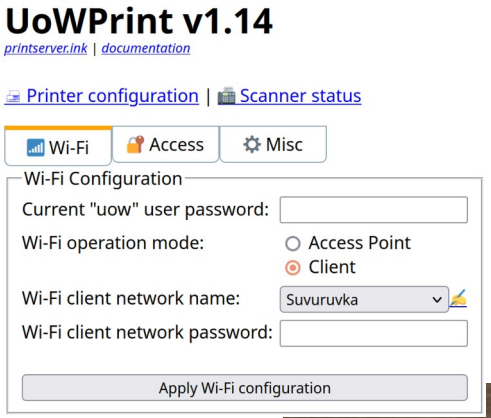
ValdikSS
@ValdikSS

It turns out that there are no modern print servers on the market. I decided to make my own: it allows you to connect old printers via USB and get printing and scanning without drivers via Wi-Fi via AirPrint/ Mopria.
Works on Windows, Linux, macOS, Android, iOS.

I'm thinking of making a mini-PRODUCT. Should I? →



From DIY to retail: features



- Meet user needs
  - ***Enable printing from any device and operating system***
  - ***Support as many printers and scanners as possible, emulate x86 proprietary drivers if needed***
- Make it user friendly
  - ***What could be pre-configured, should be pre-configured***
  - ***What could be automated, should be automated***
  - ***Simple and clear web interface***
  - ***Connect with QR code***
  - ***Access by .local domain, not IP address***
  - ***Embed documentation and configuration how-tos***
  - ***Minimize user intervention***

Your mom should be able to set it up without you

From DIY to retail: OS

- Prevent user from breaking the device
  - *Power loss should not corrupt the filesystem at any point ⇒ read-only rootfs*
  - *Power loss should not lead to configuration loss ⇒ read-write config partition, sync fs and ensure state*
  - *Support for factory reset ⇒ hold hardware button to reset the state*
- Firmware updates from USB flash
- Secure by default
  - *Firewall (block IPv6 remote access)*
  - *Unique per-device credentials*
  - *No default or hard-coded passwords*

csa-iot.org
IoT Device Security Specification 1.0
compliant (mostly) 😆

From DIY to retail: customers

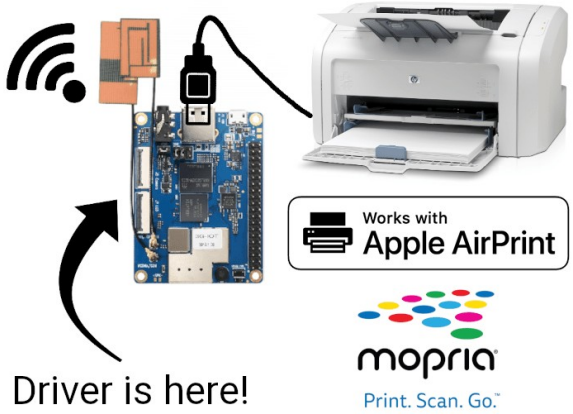
End users don’t know much about technology

- ***“How do I print from the smartphone?”***
- ***“How to connect USB printer to Wi-Fi?”***
- ***“Can’t install print drivers on Windows ARM Snapdragon!”***

✅ Convert your old USB printer (or MFP) into Wi-Fi printer/MFP

✅ Print and scan without drivers from Windows/macOS/Linux, as well as iOS/Android

No driver required



Driver is here!

From DIY to retail: geeks

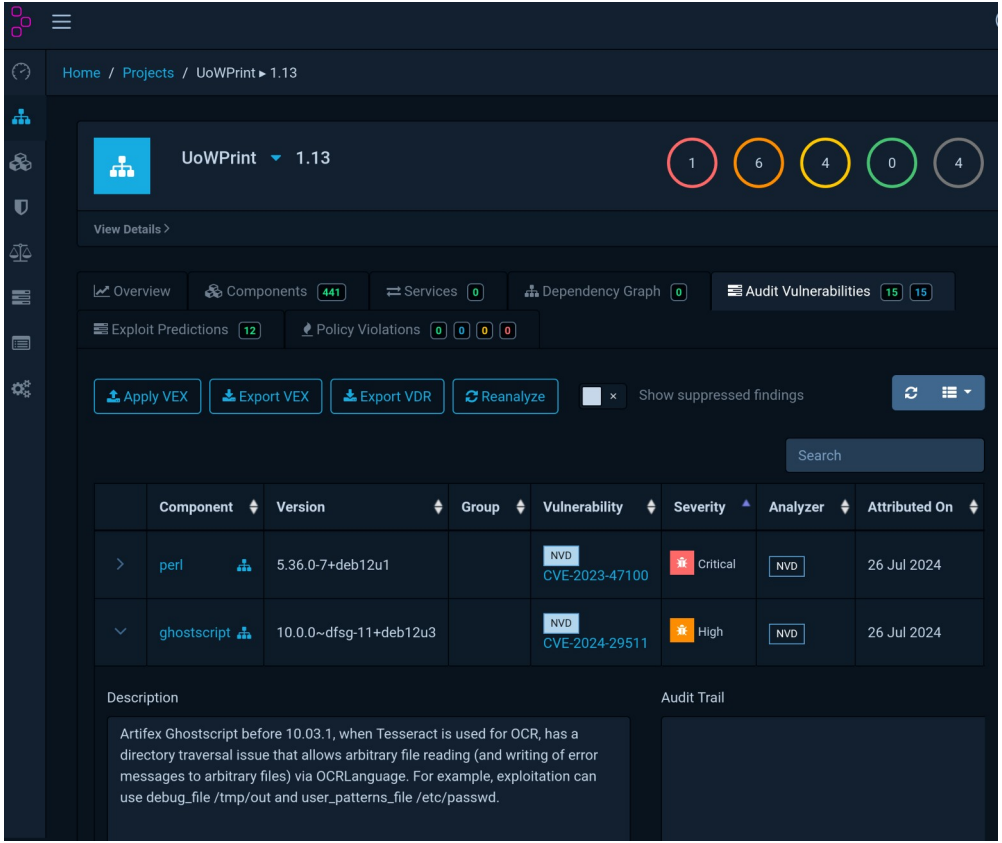
- **Debian 12**
  - *Easily customized, well supported*
  - *Simple cross-compilation process*
- **4 commands to build the firmware from scratch**
  - ***mkosi**, as easy as **docker build***
- **Additional software packaged in *.deb*'s**
  - *Simplified management and version control*

How to build from scratch

Run as root.

1. `./mkosi.sh builder` bootstraps builder image, cross-compiles necessary packages, builds ubi host utilities
2. Build the kernel and littlekernel (bootloader):
   - `mkosi --default mkosi.builder shell bash -c 'rm /etc/resolv.conf; echo nameserver 8.8.8.8 > /etc/resolv.conf'`
   - `mkosi --default mkosi.builder shell /patches/kernel/build.sh`
   - Manually copy `usblp.ko` and `r8152.ko` from the kernel directory to the `mkosi.extra-image/usr/lib/modules/`
3. `./mkosi.sh image` bootstraps final armv7 image, installs all the necessary packages including cross-compiled from builder, applies `mkosi.extra-image` files
4. `./mkosi.sh ubi` generates UBIFS filesystem and UBI disk image

From DIY to retail: geeks



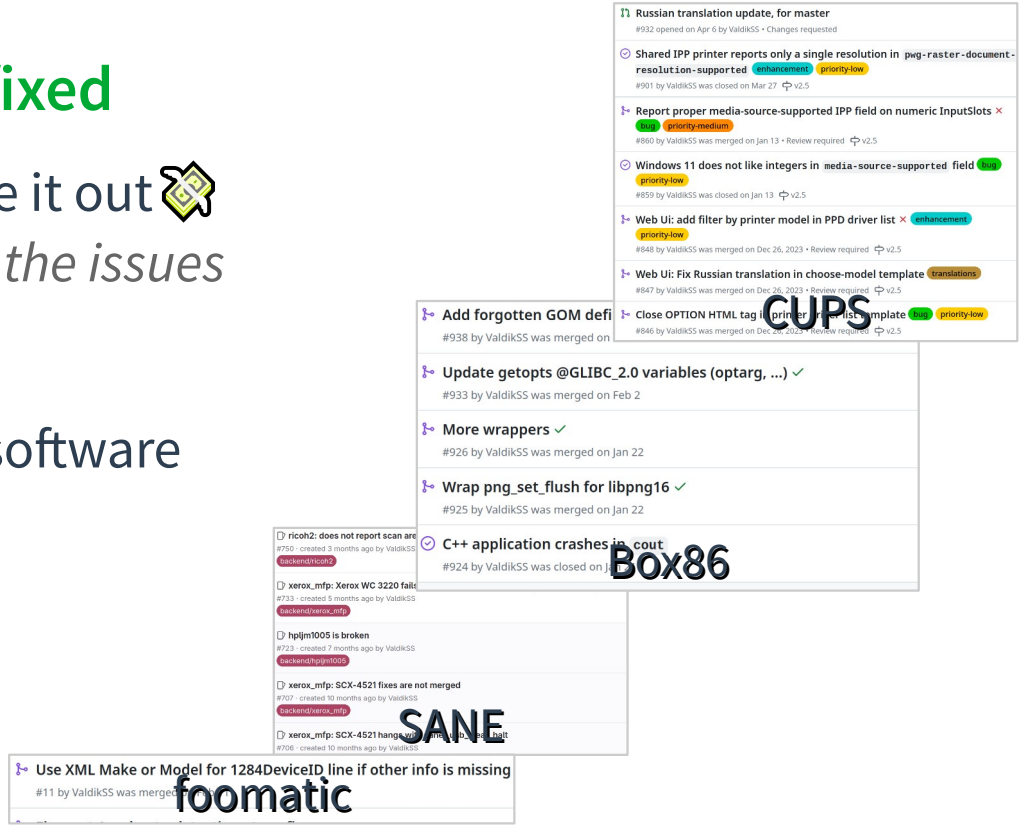
- **Software bill of material (SBOM) generation**
  - *Vulnerability tracking with DependencyTrack*

Geeks could rebuild the image and “fix vulnerabilities” on their own :)

Contributions

Contributions: software

- **Open source used ⇒open source fixed**
  - Printer doesn't work? I *have to* figure it out
    Ended up buying 3 printers to debug the issues
  - Fix it if I can, file an issue if I can't
  - Increased attention leads to better software



Contributions: financial

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¿¿¿ ???

Fund software with hardware

Each device (≈$25) contributes:

- $2 to CUPS
- $2 to SANE
- $2 to AirSane
- $2 for future open driver development

Goals met

- ≈$320
  have been donated to SANE and CUPS each
  Not much, but this is just beginning
- All devices are **sold out**
  125 pcs of $8 Orange Pis have ran out, that's all they had
  Substandard hardware successfully reused for good
- My LBP-1120 is printing 👍
  I wrote my own print driver for CAPTv1 printers as well, but proprietary is used for now
- Users are happy and ask for more devices 😄
  Next batch would be based on another hardware, more capable but more expensive

Takeaways

- **People need modern print server**
  The demand is real, existing retail devices don’t meet it
- **Hardware and software synergy**
  It’s just the software for developers,
  It’s just the hardware for end users
- **Somebody needs to debug the issues**
  The user can’t do that,
  The developer can’t do that without the hw (most of the time)

Thanks!
Questions?

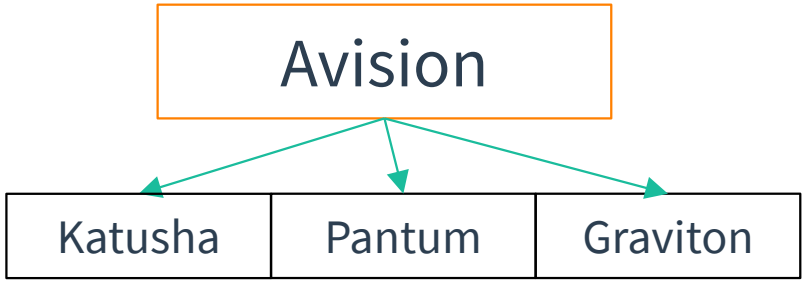
https://printserver.ink

(extra)

Notable bugs: Windows

- **Unable to use custom paper dimensions**
  - Not an issue for regular A4/Letter printers
  - Huge issue for photo printers and **label/receipt printers**
- **Any minor error leads to inability to install printer**
  - Windows is very picky to printer attributes
  - Silent errors without user-visible error message
  - Found and fixed 2 bugs
- **No feedback on bug reports**
  - Forum moderators ask to use feedback hub
  - Feedback hub is never read by anyone
  - Feedback hub is an app, not a web service — not indexed by search engines

GPL compliance: printer manufacturers



File Edit View Search Tools Help

Katusha_M240

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00024950 FF FF FF FF FF FF FF FF 02 00 00 00 00 00 00 00 ................
00024960 01 00 00 00 01 00 00 00 00 00 00 00 02 00 00 00 ................
00024970 00 00 00 00 02 00 00 00 01 00 00 00 01 00 00 00 ................
00024980 02 00 00 00 00 00 00 00 00 00 00 00 01 00 00 00 ................
00024990 02 00 00 00 FF FF FF FF FF FF FF FF FF FF FF FF ................
000249a0 4A 42 49 47 2D 4B 49 54 20 32 2E 30 20 2D 2D 20 JBIG-KIT 2.0 --
000249b0 28 63 29 20 31 39 39 35 2D 32 30 30 38 20 4D 61 (c) 1995-2008 Ma
000249c0 72 6B 75 73 20 4B 75 68 6E 20 2D 2D 20 4C 69 63 rkus Kuhn -- Lic
000249d0 65 6E 63 65 3A 20 47 50 4C 0A 24 49 64 3A 20 6A ence: GPL.$Id: j
000249e0 62 69 67 2E 63 20 31 32 39 37 20 32 30 30 38 2D big.c 1297 2008-
000249f0 30 38 2D 32 37 20 31 39 3A 31 38 3A 33 37 5A 20 08-27 19:18:37Z
00024a00 6D 67 6B 32 35 20 24 20 00 6A 62 69 67 5F 61 72 mgk25 $ .jbig_ar
00024a10 2E 63 00 63 78 20 3E 3D 20 30 20 26 26 20 63 78 .c.cx >= 0 && cx
00024a20 20 3C 20 34 30 39 36 00 73 73 20 3C 20 31 31 33  < 4096.ss < 113
00024a30 00 73 2D 3E 62 75 66 66 65 72 20 21 3D 20 30 78 .s->buffer != 0x
00024a40 66 66 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ff..............
```

From	Markus Kuhn <Markus.Kuhn@cl.cam.ac.uk>
To	ValdikSS <iam@valdikss.org.ru>, mgk25@cl.cam.ac.uk
Subject	**Re: JBIG-KIT license question**
Date	Tue, 31 Oct 2023 19:23:08 +0000
DKIM	Valid (Signed by cl.cam.ac.uk) SPF: pass DMARC: pass

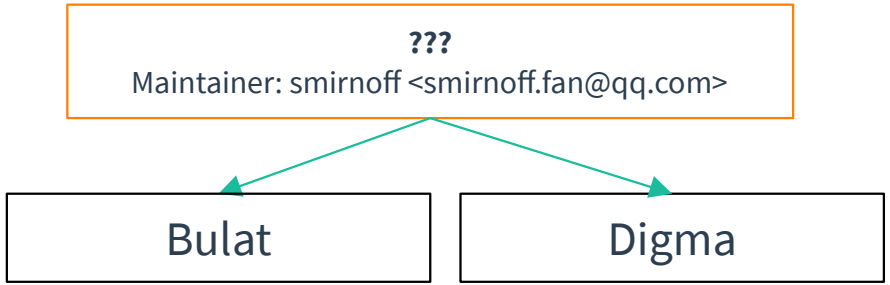
On 31/10/2023 19:10, ValdikSS wrote:

> Could you please confirm or deny that Avision & Pantum & Katusha have included GPL version of your software library code and not a commercial license, so I can request the driver source code based on GPL license from them?

I've never heard of the names Avision & Pantum & Katusha.
These names do not appear on my list of companies that
have bought a JBIG-KIT licence.

Since companies sometimes change name, get sold, or trade under
different brand names, we ask companies who have purchased a
commercial licence to replace in their use of the code
in the string "Licence: GPL" the letters "GPL" with an
alphanumeric licence code that is in the contract, such
that we can easily match up their licence contract with their
use of the software.

GPL compliance: printer manufacturers (2)

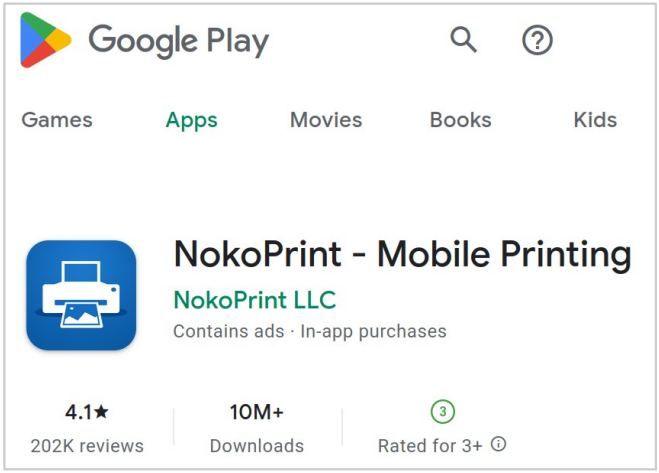


digma-rip

```
00011400 72 6F 63 65 73 73 20 22 25 73 22 3A 20 55 6E 6B rocess "%s": Unk
00011410 6E 6F 77 6E 20 66 69 6C 65 74 79 70 65 2E 0A 00 nown filetype...
00011420 25 73 40 25 73 00 00 00 2D 2D 76 65 72 73 69 6F %s@%s...--versio
00011430 6E 00 00 00 00 00 00 00 66 6F 6F 6D 61 74 69 63 n.......foomatic
00011440 2D 72 69 70 20 6F 66 20 63 75 70 73 2D 66 69 6C -rip of cups-fil
00011450 74 65 72 73 20 76 65 72 73 69 6F 6E 20 31 2E 32 ters version 1.2
00011460 37 2E 34 00 00 00 00 00 22 6D 61 6E 20 66 6F 6F 7.4......"man foo
00011470 6D 61 74 69 63 2D 72 69 70 22 20 66 6F 72 20 68 matic-rip" for h
00011480 65 6C 70 2E 00 00 00 00 2D 2D 68 65 6C 70 00 00 elp.....--help..
00011490 2D 76 00 00 00 00 00 00 2D 68 00 00 00 00 00 00 -v......-h......
000114a0 43 55 50 53 5F 53 45 52 56 45 52 52 4F 4F 54 00 CUPS_SERVERROOT.
000114b0 2F 65 74 63 2F 66 6F 6F 6D 61 74 69 63 2F 66 69 /etc/foomatic/fi
000114c0 6C 74 65 72 2E 63 6F 6E 66 00 00 00 00 00 00 00 lter.conf.......
```

Based on foomatic-rip 1.27.4

GPL compliance: nokoprint



Supported Printers

- HP: Officejet, LaserJet, Photosmart, Deskjet, Envy, Ink Tank, and other models
- Canon: PIXMA, LBP, MF, MP, MX, MG, SELPHY, and more
- Epson: Artisan, WorkForce, Stylus, and other models
- Brother: MFC, DCP, HL, MW, PJ, and other models
- Samsung: ML, SCX, CLP, and other models
- Xerox: Phaser, WorkCentre, DocuPrint, and other Models
- Dell, Konica Minolta, Kyocera, Lexmark, Ricoh, Sharp, Toshiba, OKI, and more
- Many other printers

From ValdikSS <iam@valdikss.org.ru>

To info@nokoprint.com 30.07.2024, 13:31

Subject **Re: GPL source code question** OpenPGP

Date Tue, 30 Jul 2024 13:31:36 +0300

```
Hello, I haven't received a reply from you. It may be lost, please resend.


On 27.05.2024 22:42, ValdikSS wrote:
> Hello,
>
> I discovered that Nokoprint Android application uses splix (Samsung SPL)
> driver for Samsung and Xerox printers, along with GhostScript and other
> printer drivers.
>
> splix project is licensed under GNU GPLv2 license.
> GhostScript is licensed under GNU AGPLv3 license.
>
> These licenses require to disclose the source code. As far as I can tell, you
> use these projects bundled in a single .so file.
>
> Where could I get the source code of your modifications? I could not find the
> code anywhere on the website, Google Play link, or Github.
>
> Thanks.
```

UoWPrint v1.14

printserver.ink | documentation

Printer configuration | Scanner status

Wi-Fi | Access | Misc

Miscellaneous configuration

Current "uow" user password:

May cause issues with other printers, do not enable unless necessary

- [x] Enable SSH server
- [ ] Support for USB-to-parallel port converters (LPT)
- [x] Support for Canon CAPT printers Canon_LASER_SHOT_LBP-1120
- [ ] Use foo2zjs HP firmware loader instead of hplip
- [ ] Accept only raster data (do not accept PDF and PS)
- [ ] Use GhostScript instead of Poppler for PDF to PS processing
- [ ] Suppress GhostScript errors to stdout (could fix PS printing)
- [ ] Disable AirSane HP AIO scanner driver
- [ ] Run AirSane x86 for emulated scanners (Panasonic, Brother)

Apply