HP Jet Fusion 3D Cloud Connection Security

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1 Introduction

HP Jet Fusion 3D printers are smart devices that enable additional functionality and services through a connection to the HP Cloud. HP is leading the transformation from analog to digital production means in 3D, which will enable the next industrial revolution.

Smart device functionality includes:[1]

Machine learning to maximize part quality based on printing parameters and device models that adapt and evolve over time

Consistent and predictable part outcomes based on product and process improvements driven from aggregated system telemetry and usage data

Predictive device maintenance to anticipate required maintenance and part replacement, thereby minimizing printing downtime through planned interventions

As smart devices, HP Jet Fusion 3D printers will provide the best customer experience in the market, as well as solutions that evolve and improve over time.[2] This is made possible in part by applying statistical analysis and machine learning techniques to data gathered from connected devices. The installed base of connected devices combined with cloud intelligence make up the HP Jet Fusion 3D Cloud Ecosystem. Improvements may be deployed via device firmware updates or other means.

2 Cloud ecosystem benefits[2]

HP Cloud connected devices will provide a range of customer benefits:

2.1 Productivity

Your device information always available

Anywhere, anytime access to the status of your HP 3D solutions. HP PrintOS connection enables device status monitoring from any web browser or mobile device, from anywhere in the world (Figure 1).
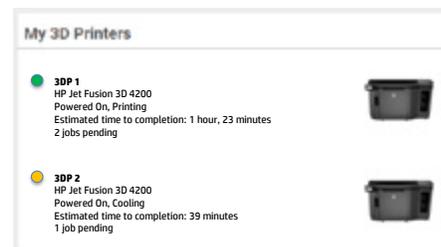

Figure 1: Device monitor

Monitor KPIs effortlessly

Data collected at HP Cloud might be used in the future to compare your productivity anonymously to other HP Jet Fusion 3D printer users. Productivity data may include: Packing densities, utilization indices, material recycling percentages, and more.

Drive higher uptime and productivity

In the future, you will get visibility of your 3D printer's performance and use data-driven insights to help improve your workflow and to plan production and interventions. Transform your service experience from reacting to unexpected incidents to proactively scheduling maintenance that helps to minimize production disruptions.

Better planning and increased efficiency

Understand usage patterns to support your business planning needs. Having usage data in the HP Cloud enables full visibility of device utilization patterns so you can plan your production accordingly.

2.2 Smart devices

Keep your devices up to date

HP will inform you when new printing parameter sets and/or device firmware are available, so you can benefit from ever improved performance and results.

Better parts over time

HP will continue to evolve HP Multi Jet Fusion 3D technology. By analyzing large volumes of printer performance data, our technical teams can provide solution updates that can help produce better parts and improve efficient production over time.

Your service needs are anticipated

Your HP technical service provider[3] will be ready to support you before you notice any problems. They will have a solution ready immediately and will plan any needed service operation so that time to repair is reduced and impact to production is minimized. Based on data collected from our installed base and the power of our Big Data tools, we will create and deliver real-time alerts to prevent certain incidents before your production is impacted.

Faster time to fix and more efficient visits
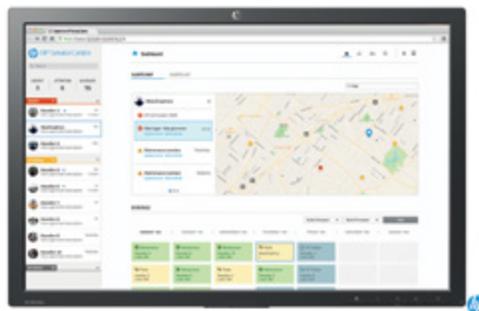
Stay in control of your IB with a superior support advantage

An HP technical service provider[3] will remotely diagnose your devices, which will help HP to fix a problem on the first visit, with the right parts and tools in hand.

3 Cloud ecosystem requirements

The productivity and smart device benefits outlined above depend on the presence of a permanent connection to the HP Cloud. For example: production, KPI, and uptime monitoring require close to real-time data from the corresponding devices. Keeping devices up to date requires that their state be known, and that updates can be made available to customers as soon as they are released. Anticipating service needs and accelerating the time to fix a problem requires that HP technical service providers[3] have the relevant real-time HP device data always available.

Part quality improvement over time and related benefits depend heavily on the application of Machine Learning techniques. Whether they be rule based, statistically based, or 'deep learning' approaches, they all require massive amounts of anonymous data over large numbers of devices and significant periods of time to enable convergence and testing of the algorithms. HP's extensive domain knowledge regarding digital printing processes in general, and HP Jet Fusion 3D printing technology in particular, provide the necessary scaffolding onto which Machine Learning approaches are mounted. Data for Machine Learning algorithms is used in an anonymous and aggregated fashion, resulting in enhanced baseline device parameters that are made available for individual customers to further improve upon as they see fit.

4 How the cloud ecosystem works

4.1 Connectivity architecture

Information is collected from the HP 3D printing solution by the HP SmartStream 3D Command Center software (hereinafter referred to as "Device Data"). The HP SmartStream 3D Command Center software is installed on a PC within the customer network. Device Data is accessed using Hyper Text Transfer Protocol Secure (HTTPS), with the HP 3D printing devices acting as servers and the HP SmartStream 3D Command Center software as the client. There is no direct connection from the HP 3D printing devices to the cloud or to the Internet. The customer computer hosting the HP SmartStream 3D Command Center software is located within the customer's local network, so customer firewalls or any other protection mechanism enabled in the network will ensure that data transmission between the HP 3D printing devices and HP SmartStream 3D Command Center software cannot be intercepted. Data connections to the cloud are always initiated by the HP SmartStream 3D Command Center software from within the customer network, so no incoming network ports need to be opened.

Note: The customer computer onto which the HP SmartStream 3D Command Center software is installed needs to be always on and awake to maintain the connection to the   HP Cloud.

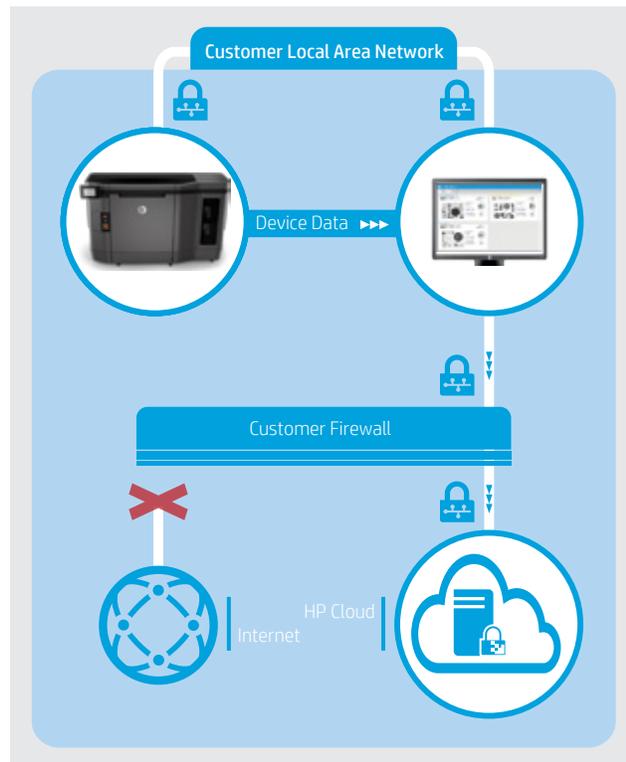The connectivity architecture is represented schematically in Figure 2 below:

Figure 2: Connectivity architecture schema

4.2 Are there any security risks or vulnerabilities involved?

All data connections from the HP SmartStream 3D Command Center software to the HP Cloud are initiated by the HP SmartStream 3D Command Center software from within the customer local area network, using the standard HTTPS secure web protocol. Only outgoing HTTPS ports (typically TCP 443) need to be opened in the customer firewall, and no incoming network ports need to be opened. Neither the HP SmartStream 3D Command Center nor any devices connected to it can be reached from the general Internet, unless the customer explicitly configures their network and firewall to allow such access (which is not required for the HP Cloud connection).

HP 3D printing solution status and health monitoring to enable the benefits described above require frequent upload of small data payloads commonly known as a heartbeat signal. This requires the HTTPS cloud connection to be always available, but outgoing connections are opened and immediately closed for each individual payload, which further reduces any potential security risks.

Although the Command Center software uses the HTTPS web protocol, it is not a web browser. It cannot be used to access anything other than the HP Cloud, and it is not affected by typical web browser vulnerabilities. Full security audits and vulnerability scans are performed on the Command Center software before release. To further enhance security, HP recommends that customers install and use virus protection software on the customer computer running the HP SmartStream 3D Command Center software, and to keep it up to date.

Printers and supporting devices run on dedicated hardware and firmware that is not affected by typical personal computer vulnerabilities. Full security audits and vulnerability scans are performed on all HP device firmware before release, and firmware update files are digitally signed by HP and verified by the HP device before installation.

4.3 Keeping your data secure

Non-anonymous Device Data is never shared with unauthorized third parties without the customer's consent. The HP Cloud stores the Device Data in HP authorized data centers which meet strict HP security standards, and the system is periodically audited to help ensure the highest level of data security.

Settings selected by a customer in the HP 3D printing solution to improve quality or performance will not be shared directly with any other customers.

4.4 What Device Data is collected?

In sum, Device Data includes the following. For a complete list of Device Data gathered, see Appendix A:

- **Device configuration information,** such as printer model and firmware version
- **Device operational status information,** such as status of consumables or alerts
- **Device lifetime usage information,** such as the quantity of agents and materials used
- **Job metadata,** such as print quality settings, materials and agents used
- **Device activity logs** generated by embedded firmware

4.5 What Device Data is NOT collected?

- Job contents are not gathered, and consequently jobs cannot be replicated based on the Device Data obtained
- Job names, part geometries, part names, or computer and job user names are not gathered
- Data not related with the HP 3D printing solution will not be accessed or collected by HP

4.6 How is Device Data transferred, stored, and used?

The HP SmartStream 3D Command Center software transmits Device Data to HP Cloud servers using HTTPS. The identity of the servers is verified, and the communication between the HP SmartStream 3D Command Center software and the HP Cloud servers is encrypted using the Advanced Encryption Standard (AES) algorithm in Cipher Block Chaining (CBC) mode, to ensure that the Device Data cannot be viewed or modified by any third party.

If the customer network is protected by a firewall, it must be configured to allow outbound HTTPS traffic, typically by opening outgoing TCP port 443. If a web browser like Internet Explorer or Chrome on the same computer that is running the HP SmartStream 3D Command Center software is able to access https://hp.com, everything will work as expected.[4] Data connections to the cloud are always initiated by the HP SmartStream 3D Command Center from within the customer network, so no incoming network ports need to be opened. Network traffic generated by the HP SmartStream 3D Command Center is light. The amount of bandwidth used is typically less than 0.5% of the total bandwidth provided by a 5 Mb/sec connection.

4.7 How to ensure that the system is correctly connected

In order to ensure your system is correctly connected and uploading data to the HP Cloud, follow these guidelines:

- Make sure that the computer where the Command Center Server is installed is always on and connected to the HP Cloud

- Use hostnames or static IP addresses in your devices and Command Center Server PC to prevent disconnections if the assigned IP address changes

- Command Center Server PC requires to have port 8080-8090 open to allow Clients to connect to it

- In order to let the Command Center Server access the cloud, you need to check that the firewall is not blocking the following endpoints:

    a. www.printos.com, port 443

    b. 3dpconfig.heleni.me, port 443

    c. us-west-2.amazonaws.com:443

    d. firehose.us-west-2.amazonaws.com port 443

- Proxy configuration is taken from the system configuration so it is not needed to setup any specific proxy for the HP software

- HTTP is used to send data between the Command Center Client and Server, so make sure this protocol is enabled in your firewall rules

Appendix A. Device Data collected by the HP SmartStream 3D Command Center

What follows is a list of device information gathered from the HP 3D printing solution:[5]

4.8 Device identification

- Printer name
- Model number
- Serial number
- Firmware release
- Printer UUID
- Printer size
- Hard disk capacity
- Memory capacity
- Date
- Uptime

4.9 Device status (heartbeat)

- Printer status
- Printer current activity

4.10 System events and alerts

For each event or alert:
- Code
- Description
- Severity
- Time stamp
- Firmware version
- Subsystem
- Debugging details

4.11 Job completion details

- Job ID (random alphanumeric ID, not related to job name or part names)
- Creation date
- Start date
- Completion date

- Source application
- Source host
- Bounding box
- Volume
- Surface area
- Density
- Number of layers
- Layer thickness
- Material type
- Material used in parts
- Recyclable material
- Print mode
- Build unit ID
- Job completion status
- Alerts triggered: ID, message, severity, time stamp
- Printing sub-tasks: Status, percentage of completion, duration, start time, end time

4.11.1 For each part within a job
- Part ID (random alphanumeric ID, not related to part name)
- Creation date
- Processing start date
- Processing completion date
- Printing start date
- Printing completion date
- Bounding box
- Volume
- Surface area
- Amount of material used
- Part completion details

4.11.2 For each layer within a job
- Size
- Duration
- Start time
- End time

4.12 Device usage counters
- Total number of jobs
- Total number of jobs finished
- Total number of layers
- Total number of parts
- Total printed volume
- Total printing time
- Total agents consumed

- Total material consumed
- Cooling system working time
- Filters status
- Lamps usage
- Intermediate tanks used
- Agent system working time
- Printhead servicing system usage
- Carriage system usage
- Total number of system errors

4.13 Printhead cleaning roll information

- Part number
- Status
- Percentage used

4.14 Agent system

For each supported agent type

- Agent used (cc)
- Number of insertions
- Installed supply status
- Installed supply level

4.15 Printheads system

For each printhead installed in the system

- Type
- UUID (random alphanumeric ID)
- Status
- Part number
- Serial number
- Agent consumed
- Installation date
- Usage time
- Recovery level
- Last error code
- Last error time stamp
- Non-HP agents used flag
- Expired agents used flag
- Warranty expiration date
- Warranty status
- Manufacturing date

4.16 Build unit system

- Total number of build unit insertions

4.16.1 For the installed build unit

- Part number
- Serial number
- Number of insertions
- Status
- Usage time
- Material type
- Recycled percentage
- Amount of material
- Non-HP material used flag
- Expired material used flag
- List of printers used with this unit: Product number, serial number, firmware release, connection, and disconnection time stamps

4.17 Device logs

- Printer session log (no customer part information included)
- Printhead logs
- Lamp control log
- Cooling servo log
- Build engine log
- State machines for every servo/element
- Trolley heating logs
- Front panel logs
- Sensor logs
- Memory usage

[1] HP may decide to offer some services based on the smart device capabilities for a fee, especially when targeting fleet device behavior or specific part property enhancements.
[2] Benefits will become available gradually as functionality is developed over time. Benefits described herein may not be available if your HP Jet Fusion 3D printers are not connected continuously to the HP Cloud as required.
[3] Services may be provided by HP, or by an authorized HP service provider.
[4] In some cases, additional firewall configuration may be required by the customer's IT department.
[5] The information collected in this appendix is subject to change upon notice to the customer.