Cloud-based Print Service to Support Work Style Innovation

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In recent years, work style innovation utilizing ICT has attracted attention. A printing environment for virtual desktops to support this work style innovation requires a system that allows printing regardless of the place or the model of the printer or multifunction printer (hereafter, printer). To that end, technologies for the virtualization of printers, print distribution, and the integration of printer applications are necessary. Fujitsu has developed FUJITSU Cloud Service Print Anywhere, a new cloud-based service that realizes convenience and security in a printing environment for virtual desktops. This service combines the technology resulting from co-creation with printer manufacturers and the technology that we have developed with form middleware to meet the needs of work style innovation. This paper presents an approach to the realization of printing as usual regardless of the place of work through the implementation of Fujitsu's work style innovation.

1. Introduction

Against a backdrop of labor shortages due to a decreasing birthrate and an aging population, work style innovation has recently started in companies for the purpose of improving productivity and securing human resources. Along with the advance of ICT, for office workers to work in the same place is becoming less important. A flexible work style not constrained by place as long as the environment offers higher work efficiency, such as working at home, a satellite office, or business trip destination and while traveling, has been gaining importance. Companies are striving to realize this innovation.

To achieve improvements in employees' expertise, co-creation with customers, creation of innovations, and improvements in business speed, Fujitsu is also working on work style innovation aimed at the development and improved productivity of each and every employee. As part of this initiative, Fujitsu introduced in April 2017, and is promoting, a telework system intended for about 35,000 employees.

The utilization of ICT is essential for the realization of teleworking. We are strengthening communication by deploying standard internal systems such as a global communication platform intended for about 160,000 employees across the entire Group, including overseas sites, and a company-wide virtual desktop infrastructure (VDI)[1] intended for about 80,000 employees in Group companies in Japan to realize work environments not constrained by time and place.

Of the issues with in-house implementation of work style innovation, this paper focuses on office printing and presents an approach to its resolution.

2. Background of print service in VDI environment

As a company-wide initiative intended for about 80,000 employees in Group companies in Japan, Fujitsu has been building a VDI environment since FY2015. This initiative is intended for work style innovation and the strengthening of measures against information leaks. In terms of work style innovation, it allows use of the same PC environment to work anywhere regardless of the place of work. From the perspective of measures against information leaks, it eliminates the risk of intrusions by malware because users are not given the authority to install programs.

Meanwhile, concerning printing, the need to print as usual regardless of the place or the model of the printer or multifunction printer (hereafter, printer) has

been clarified.

Introduction of the VDI allows users to work in the same PC environment anywhere. But to print, printers at satellite offices or business trip destinations need to be set up to make them function. However, users are not given the authority to install printer drivers as a measure against malware and are unable to set them up. In other words, no environment was provided as of 2015 to print in a VDI environment.

To meet this demand, Fujitsu offers FUJITSU Cloud Service Print Anywhere[2] as a service on the cloud platform FUJITSU Cloud Service K5.[3] The following section describes the technologies for realizing Print Anywhere, its application to internal systems, and future initiatives.

3. Technologies to support print service in VDI environment

To achieve the capability of printing anywhere using a VDI environment, authenticated printing requires that the manufacturer of the printer be transparent to the user. To achieve this, respective technologies for the virtualization of printers, print distribution, and the integration of printer applications are necessary.

The following outlines the respective technologies.
1) Technology for the virtualization of printers

To print from a PC, the capability of operating the destination printer without the need to be aware of the manufacturer, model, or place is required. To realize this capability, this technology absorbs the differences between printer manufacturers and interfaces of different models to allow printing with printers through a standardized operation and interface.
2) Technology for print distribution

This technology ensures printing by monitoring until data is actually printed out on paper. Print data instructed to be printed by a business application are spooled (temporarily saved) to narrow down business forms based on the individual or the task and are delivered to the intended output destination according to the user's instructions for printing. Print Anywhere applies the technology developed through business form printing.
3) Technology for the integration of printer applications

A printer is not simply an output device but also provides a connection and authentication device to computers in the network and an operation panel that allows operations by the operator, as well as a printing device, and functions as part of a system. For a printer, an execution platform for running applications to control these functions is prepared, but the specifications are different for different manufacturers. To offer functions and an interface independent of the manufacturer, Print Anywhere absorbs the differences between interfaces of application execution platforms for individual printers to realize standardized operability. The following details these technologies.

3.1 Technology for the virtualization of printers

A VDI virtualizes PCs to provide work environments not dependent on the place or device. In the same way, the capability of printing regardless of the place requires technology for the virtualization of printers.

The technology for the virtualization of printers consists of a common printer driver interface that does not depend on the manufacturer or model of the printer, a common print data generation technology, and a technology for absorbing differences between interfaces of individual printers.

For Print Anywhere, a common printer driver not dependent on the manufacturer or model of the printer is referred to as a virtual printer driver. A user intending to print instructs the virtual printer driver to print and uses the printer intended for printing to authenticate with an IC card. This is all that is necessary to have Print Anywhere recognize the manufacturer and model of the printer and internally call the interface for the specific printer manufacture to execute printing (**Figure 1**).

3.2 Technology for print distribution

The technology for print distribution is used for printing business forms requiring immediacy and reliability, as in bill issuing at logistics sites and the printing of documents and detailed statements at counters of public offices and hospitals.
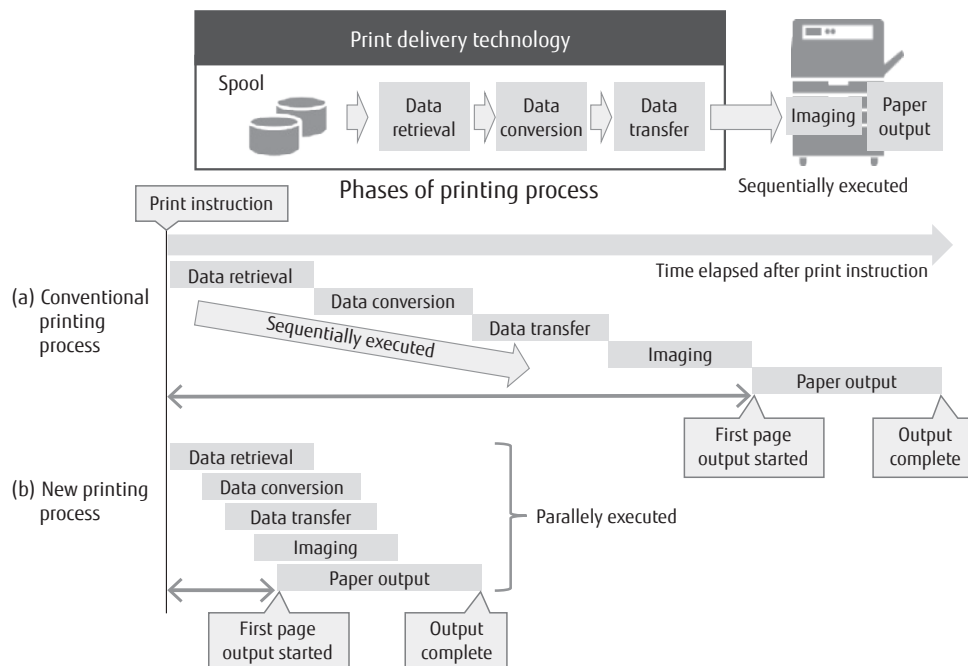
The printing process takes place in the respective phases of print data retrieval, data conversion into a format compatible with the printer, data transfer to the printer, imaging in the printer, and paper output. Sequential execution of the individual phases causes

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a long response time before the first page is output, which is illustrated in **Figure 2 (a)**. To achieve immediacy in printing, Print Anywhere executes the phases from print data retrieval to imaging in the printer and paper output in parallel as shown in **Figure 2 (b)**. To ensure reliability in printing, a fallback operation is
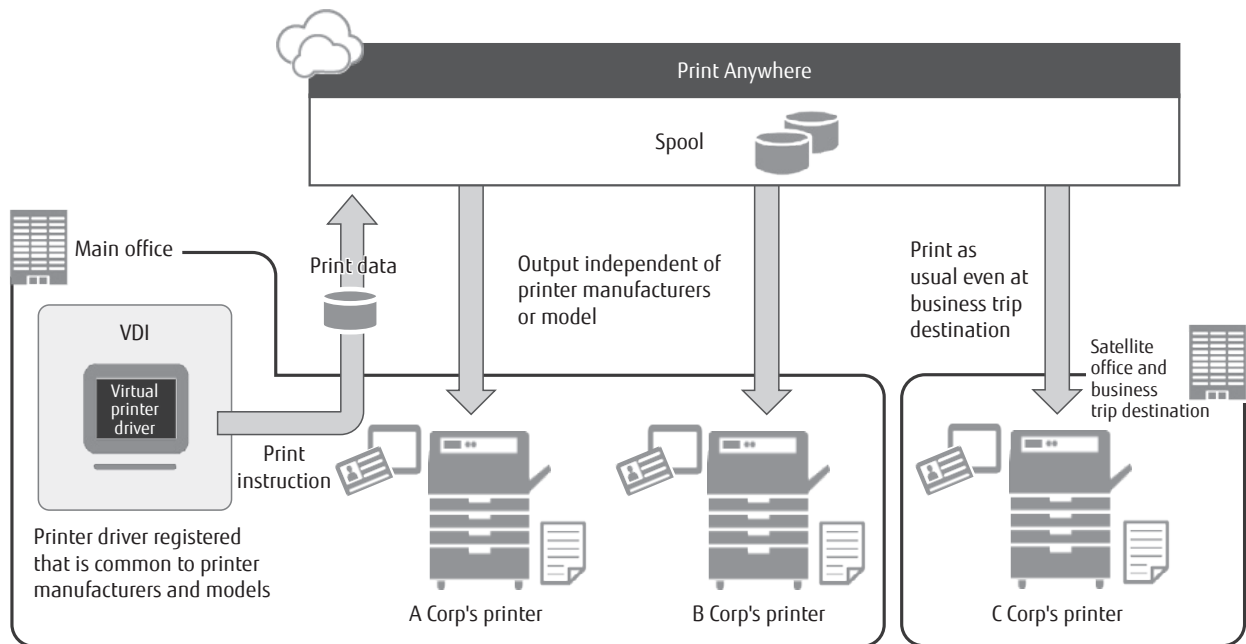
Figure 1
Printing independent of printer manufacturer or model.

Figure 2
Improvement of print response via printing process parallel execution.

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provided that allows continued printing even when a system error occurs and a function for reprinting the document in the unlikely event of printing error.

The fallback operation uses a load-balanced configuration with more than one print distribution server as shown in **Figure 3**, in which the printing process of any server generating an error is taken over by another server that is running. This allows the user to continue the task without having to reprint from the application.

The reprint function allows the user to reprint from the print data spooled in the print distribution server when any error occurs in the printer or in any of the printing process phases without having to reprint from the application, which is shown in **Figure 4**.
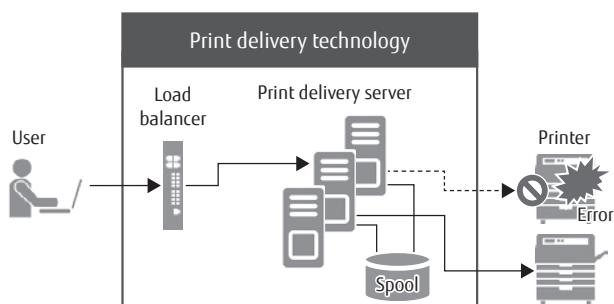
Application of the print distribution technology provides Print Anywhere with immediacy in printing and reliability to deal with any system or printing error.

3.3 Technology for the integration of printer applications

With Print Anywhere, when authentication takes
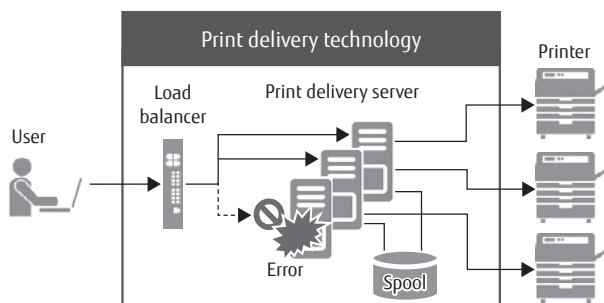
Figure 3
Fallback operation in event of print delivery server error.

Figure 4
Reprinting in event of printer error.

place using the IC card reader provided for a printer, a list of documents requested to be printed is shown in the operation panel of the printer. Then, selected documents in the list are printed via the printer right in front of the user. To realize this operation, the Print Anywhere application is first run on the printer and the application obtains the authentication information from the IC card reader. It is then sent to the Print Anywhere server to show the list of documents requested to be printed by the user, allowing print operation.

The platforms to run the application on the printer are provided by the printer manufacturers. They mainly run as Web applications but the control of devices other than the screen such as the IC card reader uses different platforms and interfaces for different manufacturers. The printer application offered by Print Anywhere absorbs the differences between manufacturers, thereby allowing printers of any manufacturer to be used with the same operation.

4. Effects of Print Anywhere

The effects of the introduction of Print Anywhere include improved user convenience, improved security, and reduced costs for the administrative department. The following describes the respective effects.
1) Improved user convenience

The printer driver UI, which is different depending on the manufacturer, has been standardized into the UI of the virtual printer driver. This allows the user to print with the same operation regardless of the place, improving convenience.
2) Improved security

From the perspective of security, the virtual printer driver is offered as a program preinstalled in the VDI environment. This renders the Administrator rights to install the printer drivers unnecessary on the part of the user and eliminates the risk of intrusion by malware, which improves security. In addition, printing is managed by the server in an integrated fashion, and who printed what to where and when can be recorded. This allows quick identification of the route and extent of any unlikely information leaks via a printed document.
3) Reduced costs for the administrative department

Simply preinstalling a virtual printer driver in the VDI environment is sufficient to relieve the burden of managing printers at all sites nationwide and the

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administrative task of updating the VDI environment involved in printer driver updating, which conventionally occurred frequently. At Fujitsu, there are more than 3,000 printers used by the Group companies in Japan, 50 to 100 of which are replaced every month. By deploying a virtual printer driver in the VDI environment, we achieved a more than 90% reduction in the printer driver management costs at the time of initial construction and during operation.

5. Creation for application to internal systems

Fujitsu has been constructing a company-wide VDI environment since 2015, but detailed requirements relating to printing were not determined when the VDI introduction plan was formulated. However, because of the short development period of only six months before the start of operations, we decided to adopt a development style of starting small with on-site implementation, uncovering potential needs and issues and gradually increasing the degree of completion while results were fed back into the process.

The following describes creation for application to the internal systems.

5.1 Co-creation with printer manufacturers

In the initial period of development, we were aware of the existence of application execution platforms on printers, but the integration of the applications was only in the conceptual stages and we were not even certain whether it was feasible. Accordingly, we established a system of co-creation with the development departments of printer manufacturers to work on prompt solutions to issues together with the

respective printer manufacturers.

At an in-house development site, we built a printer verification center equipped with printers from various manufacturers and a development environment for a printer application. We used the center to carry out the following activities together with printer manufacturers, thereby resolving issues arising from dependence on the manufacturers and models in the early stages.

1) Implementation of investigation and cause analysis

We investigated the problems generated during development of the printer application and at the time of its application to internal systems and analyzed the causes.
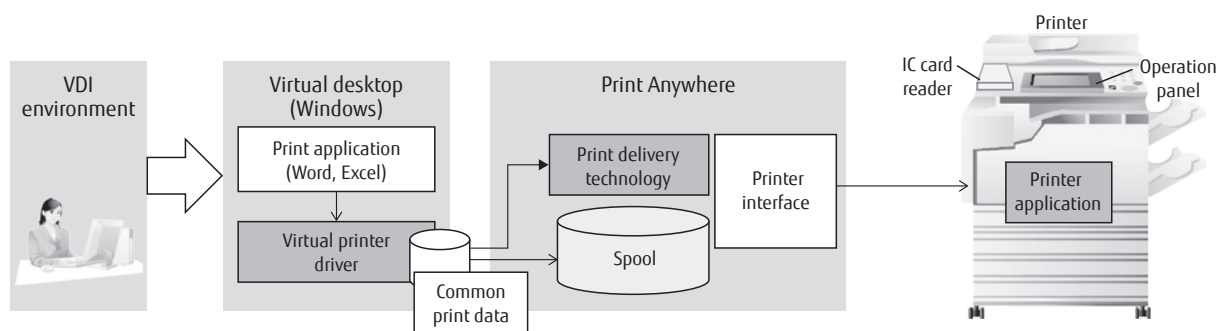
2) Study of solutions and verification of their effects

We studied the optimum measures for solving the problems and verified their effects.

In this way, we successfully integrated printer applications for use with Print Anywhere.

5.2 Agile development and on-site implementation

We promptly decided on the elemental technologies constituting Print Anywhere and came up with a grand design as shown in **Figure 5**. With waterfall development, in which the details of all requirements are identified, sorting them out alone requires more than three months. This would not be completed in time for the start of service. Accordingly, we adopted agile development, in which we repeated a process of design, development, and implementation, clarifying requirements and improving usability. The agile development process for Print Anywhere is shown in **Figure 6**. This

Figure 5
Grand design of Print Anywhere.

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development process has three features:
1) The development period is divided into short periods (sprints) of about one month each. On-site implementation is carried out when each sprint is completed and the results are fed back.
2) Development started with the virtual printer driver, which is visible to the user and provides an interface for printing.
3) Development of the printer application is carried out for each manufacturer, and the user departments are gradually increased.

In this way, we built up and refined functions to be in time for the start of use by preceding departments in October 2016 and simultaneous general release.

6. Improvements based on user feedbacks

As described in the previous section, we identified the on-site needs such as the following by using agile development to build a prototype and having it put to practical use on-site by users.
1) Sales department: "Make the printer list of documents screen show whether it is color or black and white"

To meet this need, we added an icon indicating color or black-and-white printing to the printer list of documents screen to prevent erroneous specification at the time of printing.
2) Administrative department: "Make the conventional PC environment and VDI environment co-exist, as some floors have them both"

To allow the selection of printing from the conventional PC environment and the VDI environment after employee authentication on the printer, we made improvements by co-creation with printer manufacturers to enable printers to detect printing from the respective environments, achieving co-existence.
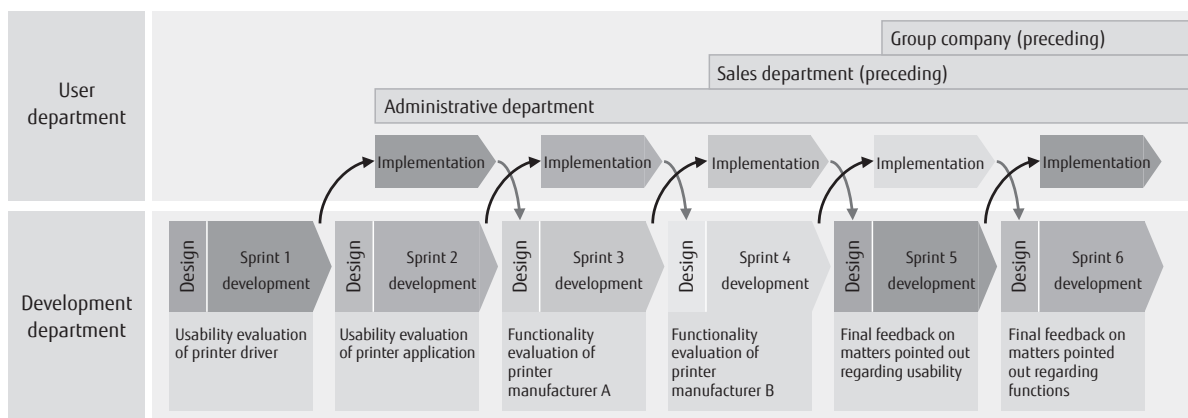3) Administrative and sales departments: "Make print times closer to those of conventional printing"

With Print Anywhere, print data is temporarily spooled on the cloud as described above, and it takes longer than conventional printing before the paper is output (**Figure 7**).
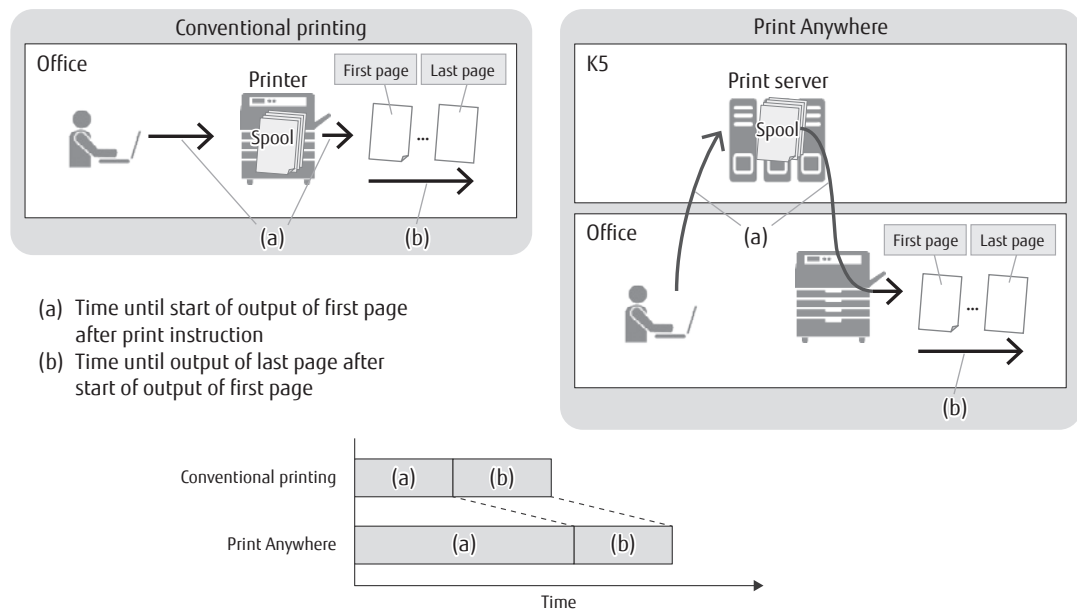
To make the experienced time delay shorter by reducing the time lag before the printer starts printing, we worked in cooperation with printer manufacturers to make improvements so that the motors run as soon as the printers receive the print data for the first page to start printing. As a result, the time taken before the motors start running have been reduced to 6.7 seconds from the initially required 28.3 seconds.
4) Administrative department: "We want to reduce infrastructure costs through the effective use of server resources"

The amount of printing in an office greatly varies depending on the day of the week and time period. To offer pleasant printing experiences to users, server resources must be prepared based on the peak during the daytime on weekdays. Meanwhile, the amount of printing decreases during the night on weekdays and on weekends, which generates a surplus in server

Figure 6
Agile development of Print Anywhere.

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Figure 7
Differences in system from conventional printing.

resources. By dynamically increasing and decreasing server resources according to these greatly varying demands, server infrastructure operation costs can be optimized.

Print Anywhere records on the server who printed what when, and this information can be utilized to understand the usage by the day of the week and time period. We analyzed this information and implemented optimum allocation of resources to each server constituting Print Anywhere to make effective use of resources, thereby achieving a reduction in the number of virtual machines (VMs) in operation to successfully reduce VM CPU core charges by 33%.

In this way, we continuously improved usability and quality by repeating a process of practical use by the user and administrative departments and feedback. We intend to continue with this initiative in the future and use these results from in-house implementation as the basis for offering services to general customers.

7. Conclusion

This paper described the technologies used for Print Anywhere and initiatives involving the in-house implementation of work style innovation.

Print Anywhere has improved usability by meeting the needs from user departments through in-house implementation. In the future, we will continue to work on improving usability by utilizing the latest technologies, such as authenticated printing by biometric authentication technology and further reductions in print times and infrastructure costs through AI technology.

References

1) Fujitsu: In-house practical case of Virtual Desktop Infrastructure Solution—Fujitsu Ltd. (in Japanese).
http://www.fmworld.net/biz/fmv/solution/thinclient/case02.html
2) Fujitsu: FUJITSU Cloud Service Print Anywhere (in Japanese).
http://jp.fujitsu.com/solutions/cloud/saas/application/print-anywhere/
3) Fujitsu: FUJITSU Cloud Service K5.
http://www.fujitsu.com/global/services/hybrid-cloud/platforms/k5/

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