Realization of Sharing Economy Centered on On-Demand Transportation Services

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Recently, the sharing economy market is becoming increasingly competitive due to the expansion on a global scale and entry of diverse categories and types of businesses. In Japan, companies from various sectors gathered together to establish the Sharing Economy Association, Japan in December 2015 for the purpose of popularizing and developing the sharing economy. Vigorous activities are also being carried out including the relaxation of regulations surrounding the sharing economy and the operation of a sharing economy certification system. Currently, its commercialization is under way in various sectors, one of which is ridesharing services mainly in provincial cities. However, businesses often fail to endure for reasons such as varying vehicle operation rates, insufficient revision of operation plans, and shortsighted business evaluations. Accordingly, Fujitsu offers the SPATIOWL On-Demand Transportation Service and works on data utilization, the linking of transfer and operation information, stimulation and creation of demand, and support for business improvement by connecting with other services. This paper presents the features of the SPATIOWL On-Demand Transportation Service technology developed and future prospects of this service.

1. Introduction

For the purpose of popularizing and developing the sharing economy, the Sharing Economy Association, Japan was established in December 2015. The Association defines the sharing economy as a new economic movement based on sharing (leasing, trading, and offering) among individuals via online platforms.[1)]

Use of the sharing economy has started in Silicon Valley and has spread worldwide, and the market is expanding on a global scale. According to the 2016 White Paper on Information and Communications in Japan,[2)] the size of the sharing economy market of various countries in total was about 15 billion dollars in 2013 and is expected to increase to about 335 billion dollars by 2025. The White Paper also says that the market size in Japan was about 23.3 billion yen in FY2014 and is expected to increase to 46.2 billion yen by FY2018.

The sharing economy is roughly classified into five different types: goods, places, skills, vehicles, and money. In the field of vehicles, rideshare—in which general drivers use their private vehicles to transport others—is a representative service. Of the top 10 unicorn companies (privately held ventures with an estimated value of over 1 billion dollars) in the world, Uber and Didi Chuxing are attracting attention as rideshare businesses.

Since 2014, Fujitsu Laboratories has used an on-demand transportation technology capable of simultaneously improving business profits and user satisfaction called Flexible Mobility on Demand (FMOD) to work on various field trials in Japan and Singapore.[3),4)] We made use of the know-how and findings obtained through the field trials to offer SPATIOWL On-Demand Transportation Service, which is specialized for ridesharing. We have named this service On-Demand Transportation because it meets the demands of users in real time better than conventional demand-responsive transportation and provides the optimum forms of transportation.

This paper describes the present conditions of demand-responsive transportation and presents the major features of the SPATIOWL On-Demand Transportation Service and a future outlook for the service.

2. Present conditions of demand-responsive transportation

Demand-responsive transportation is a type of service in which a user reserves the service with a transportation service operator by providing the desired departure time or arrival time, pickup location, and dropoff location by phone or other means; the driver then gives the user a ride to the dropoff location. The relaxation of regulations with the amendment to the Road Transportation Act in 2006, progress in ICT, and other factors have led to a reduction in workload on operators engaged in the acceptance of reservations, creation of operation plans, and allocation of vehicles. The services have been introduced mainly in provincial cities. However, there are cases in which it is not possible to continue business due to reasons such as the following:

1) Declining profitability due to the deviation of vehicle operation rates

In demand-responsive transportation, operation depends on users' requests and demand is inclined to vary. The Road Transportation Act mandates the retention of dedicated vehicles, which makes it difficult to adjust the number of vehicles flexibly according to demand. Demand variations are likely to occur particularly in areas with many users with similar behavioral patterns and the overall vehicle operation rates tend to decrease. Vehicles are often operated by chartering dedicated vehicles from transportation service operators for certain time periods, which incurs fixed costs even in the time periods when the vehicles are not in operation, resulting in a decline in profitability.

2) Service degradation due to insufficient revision of operation plans

Local governments that have introduced demand-responsive transportation may be unable to sufficiently revise operation plans after their introduction. Demand-responsive transportation is based on the assumption that discussions by the relevant parties (including the municipalities, prefecture, Transport Bureau, transportation operators, representatives of resident users, and road and transportation administrators) are coordinated at the regional public transport council and consensus is reached. To build consensus, local governments generally conduct questionnaire surveys and hold interviews to make operation plans before introduction.

However, few local governments revise the operation plans after their introduction according to the users' needs. One reason is that, while operation plans require continuous improvement through the analysis of user questionnaire results and operation log data, it is difficult to secure staff specialized in demand-responsive transportation.

3) Insufficient linking within intraregional transportation

In provincial cities, recently trials are being conducted to improve the low ridership of route bus services such as changing the scheduled fixed route services into demand-responsive services, provide demand-responsive transportation that uses taxi vehicles, and provide paid transportation by private vehicles in underpopulated areas. However, transportation assuming a region as one united form cannot be established due to the insufficient linking between intraregional transportation, and there are many cases in which the convenience of users is not sufficiently improved.

4) Business interruption due to shortsighted business evaluations

Demand-responsive transportation often receives support for the operation and vehicle purchase expenses from the Project for Ensuring, Maintenance and Improvement of Local Public Transportation Systems by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and subsidies from local governments. Subsidized projects operated by the national government are evaluated in the short term, such as within three years, and local governments tend to evaluate mainly the income and expenditure of a given project.

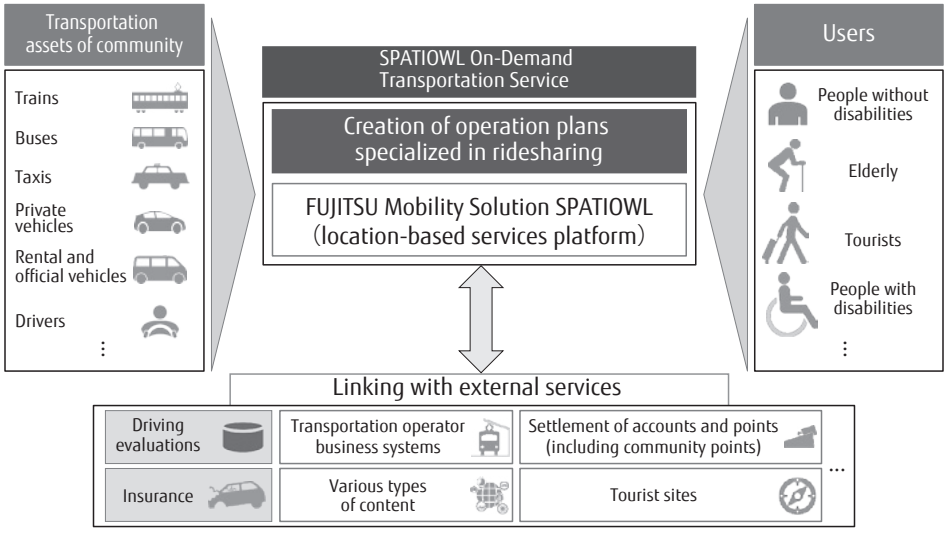
If subsidization is running out due to the unfavorable ratings of the project and the expiration of the subsidy period, there is a high possibility that the project will be terminated. These new community transportation services require a certain period of time until they become fixed in the region. It is very difficult to measure the direct and indirect (primary and secondary) effects in the short term.

3. Toward realizing on-demand transportation services

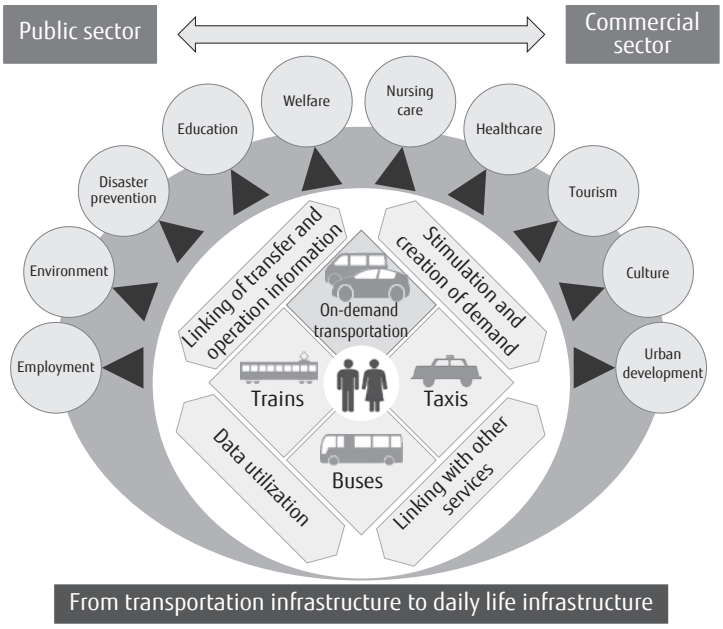
Based on the present conditions of demand-responsive transportation, Fujitsu worked on the development of the SPATIOWL On-Demand Transportation Service.

This on-demand transportation service automates an entire sequence of operator tasks such as accepting reservations by phone, checking the status of reservations and figuring out the operation routes, and allocating vehicles. This service realizes the effective operation of demand-responsive transportation without depending on the capability of the operators.

This service is established based on two steps. Step 1 is to realize a sharing economy of mobility linked with public transportation systems such as trains, buses, and taxis, and external services such as driving evaluations and insurance [**Figure 1 (a)**]. Specifically, it will support operation management work specialized in ridesharing using conventional demand-responsive transportation and paid operation of private vehicles in underpopulated areas. To enable operators and operation administrators to manage operations safely with paid passenger transportation using private vehicles,



(a) Step 1: Automation of operation plans and linking with external services



(b) Step 2: Linking with daily life services

Figure 1
Concept of SPATIOWL On-Demand Transportation Service.

driving diagnosis data collected and analyzed through the fault diagnosis connector (OBD II connector) for pickup vehicles are provided.[5)]

Step 2 includes the utilization of the operation log data stored in the database, the linking of transfer and operation information, stimulation and creation of demand and linking with other services. This service aims to provide a platform that supports basic infrastructure for daily life in addition to the transportation infrastructure [**Figure 1 (b)**].

The following sections present the individual steps.

4. Features of operation plan creation

This section describes the features of Step 1 in the preceding section (**Figure 2**).

4.1 Ensured punctuality and improved sharing rate

Conventional demand-responsive transportation generally adopted a semi-demand responsive system that creates optimal operation routes after collecting users' reservations regularly. However, service flexibility is low as this system does not accept the user reservation after closing the reservation.

This service adopts a full demand-responsive system, which implements an operation plan generation algorithm specialized in ridesharing and processes user reservations in real time. Each reservation is provided with a temporal buffer, which allows the sharing rate to be improved while ensuring the existing reservation time even if new reservations are accepted. In semi-mountainous areas where adopting a full demand-responsive transportation system is difficult, a semi-demand responsive system is used as a supplement and a hybrid (semi and full) demand-responsive system is also provided that is capable of handling users even after the reservations are closed.

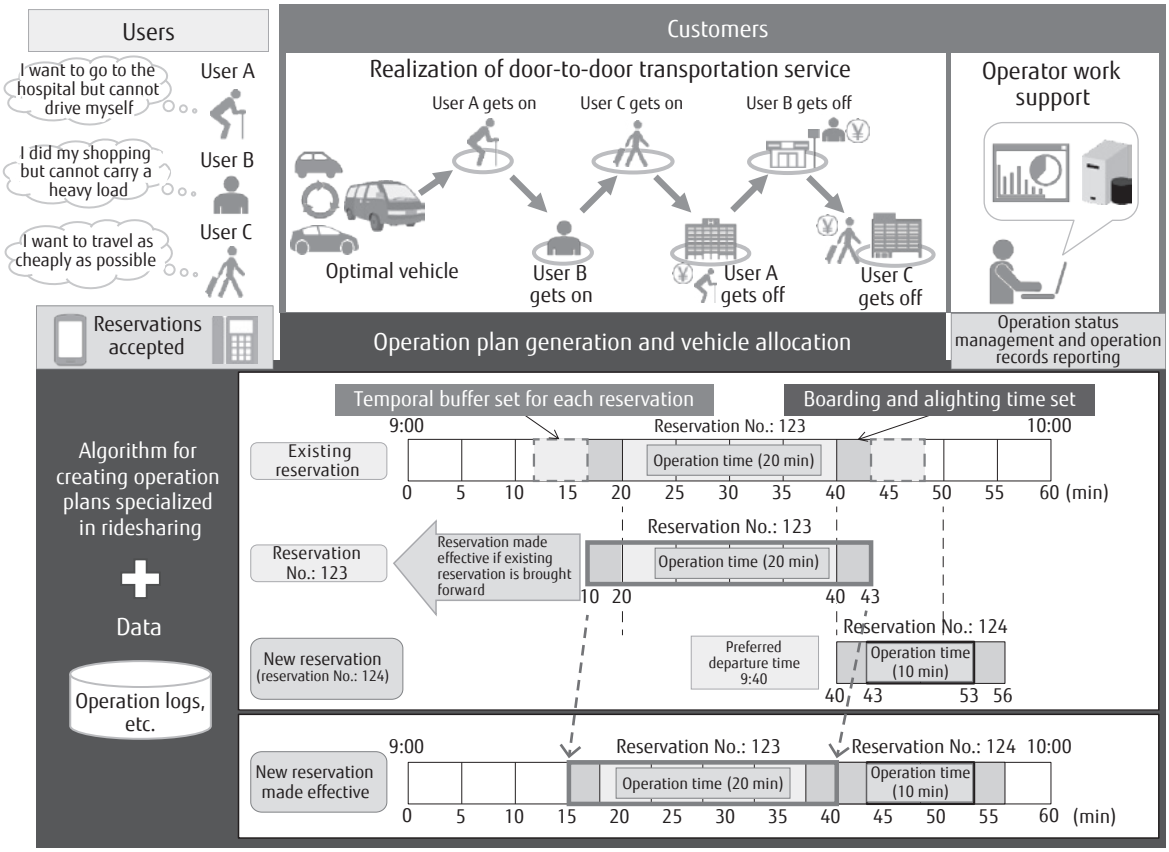


Figure 2
Visualization of creation of operation plans specialized in ridesharing.

4.2 Utilization of user information

Operation plans considering user characteristics can also be created. For example, setting the boarding and alighting times according to the attributes of users can increase the accuracy of operation plans, such as one minute for persons without disabilities, three minutes for the elderly, and five minutes for wheelchair users. In this way, sharing user information with operators and drivers allows the provision of high-quality and efficient mobility services.

4.3 Cost reduction by linking private vehicles for paid passenger transportation

With demand-responsive transportation, dedicated vehicles must be secured as required by the Road Transportation Act, which was mentioned earlier. Local governments set the number of service vehicles in consideration of non-peak and peak demand to reduce operational expenses together with the demand-responsive transportation businesses. However, setting the number of dedicated vehicles according to non-peak hours causes insufficiencies in the number of vehicles during peak hours, and will result in lower reservation rates. Setting the exclusive number of vehicles according to peak hours generates waste during non-peak hours and it increases the workload for the local government.

Linking with private vehicles for paid passenger transportation, which is being introduced in many regions recently, is effective as a solution. Specifically, operation expenses can be saved by using existing demand-responsive transportation vehicles to meet a certain level of demand, and private vehicles for paid passenger transportation to meet the demand in the peak morning and evening hours. Another possibility is to allocate private vehicles for paid passenger transportation in remote areas where ridesharing is unlikely to succeed.

With this service, vehicles for demand-responsive transportation and private vehicles for paid passenger transportation can be linked. This allows the centralized management of operation schedules for all vehicles. Private vehicles for paid passenger transportation are equipped with a driving evaluation terminal for ensuring the safety of passengers, which enables the operator to grasp the operation status of drivers in real time. In addition, data collected from the driving evaluation terminals can be analyzed to display the calculated driving performance (overall points) in the operator application to achieve safety management of the drivers and passengers (**Figure 3**).

5. Future direction

The following four activities are possible toward Step 2 of this service described in Section 3.

5.1 Review of operation plans utilizing operation log data

This service analyzes the operation log data stored in the database in real time and reports the operation results using the operator application. However, this

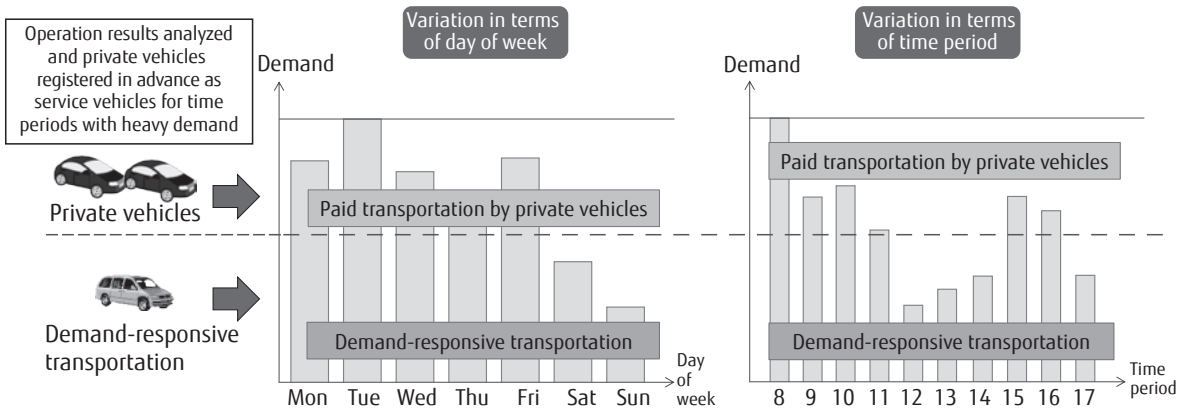


Figure 3
Visualization of linking demand-responsive transportation and paid passenger transportation by private vehicles.

is still insufficient as a material to consider the revision of operation plans. In the future, to make use of operation log data as findings and know-how for the introduction design of this service and revision of operation plans, reporting functions that utilize AI technology must be enhanced. For local governments without sufficient transportation human resources, support for the improvement of operation plans will be provided by running a plan-do-check-act (PDCA) cycle efficiently while sharing the know-how with other local governments and making use of consulting services.

5.2 Linking transfer and operation information with regional public transportation systems

The MLIT offers efficient and effective support with activities for ensuring and maintaining community transportation by linking regional public transportation systems such as trains, buses, taxis, demand-responsive transportation, and paid passenger transportation by private vehicles. With this service, the function of ensuring the reservation time can be used to create operation plans in line with the schedules of public transportation systems to handle the mobility needs that are interspersed within a service area. This can be utilized to provide users with information about smooth transfers to public transportation systems. When demand-responsive transportation or paid passenger transportation by private vehicles compete against trains, buses, taxis, or other services, the individual regional public transportation systems can share roles and link transfer and operation information in an appropriate manner. In this way, a comprehensive public transportation network that looks at the entire region can be designed (**Figure 4**).

5.3 Stimulation and creation of demand and demand leveling through behavioral-guidance models

In 2015, Fujitsu Laboratories conducted a field trial for mitigating congestion through behavioral guidance at event, sports, and commercial facilities in Singapore. The field trial involved the use of a smartphone app to propose the behaviors and ways of spending time that are best suited to the individual event up through participants returning home.[4)]

In the future, we intend to apply the behavioral-guidance model to this service as well to stimulate and create demand and level the demand for demand-responsive transportation. Possible examples include

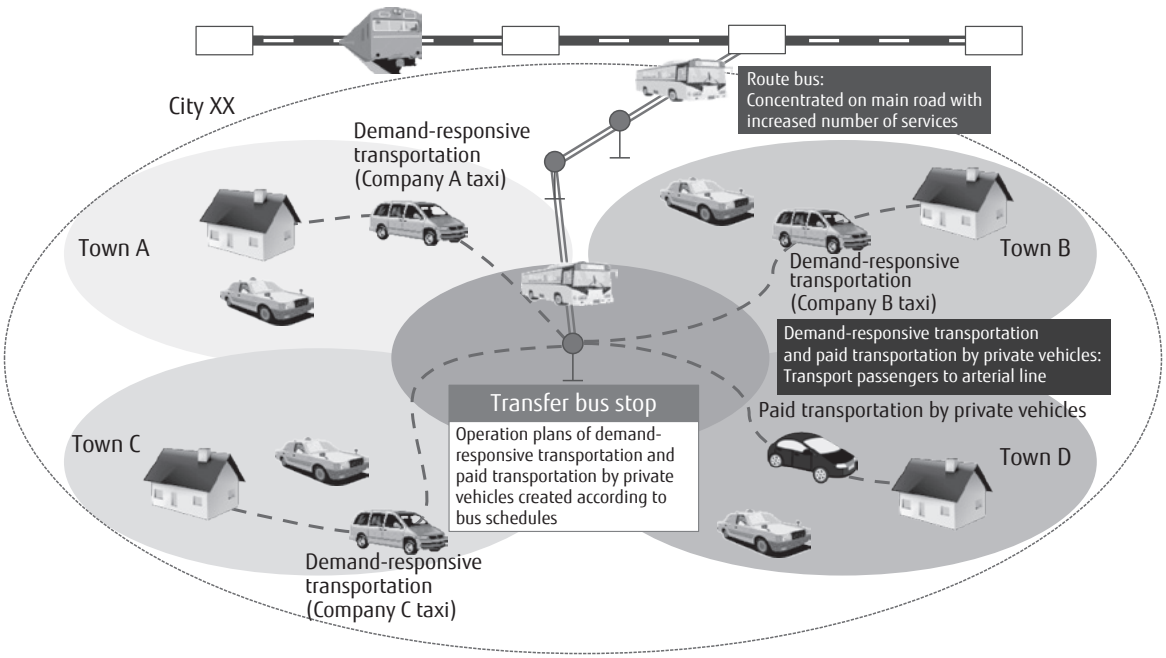


Figure 4
Visualization of linking with existing regional public transportation.

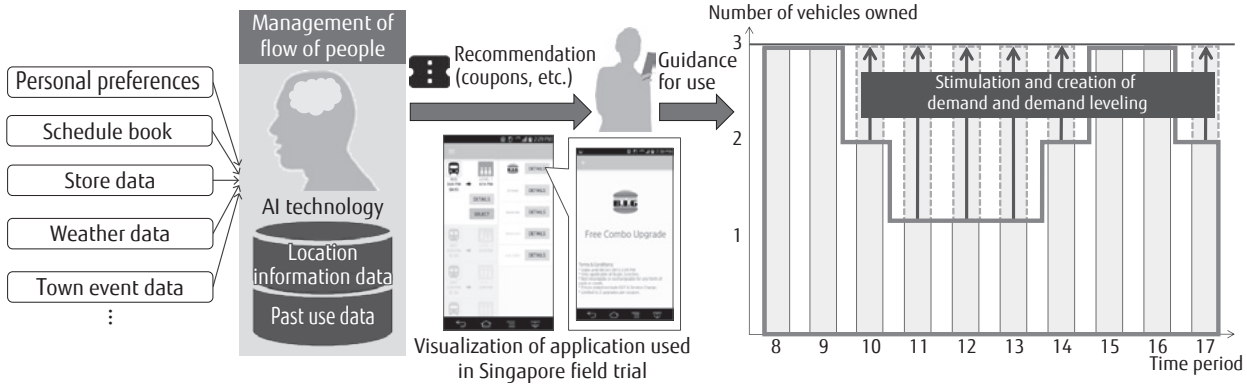


Figure 5
Stimulation and creation of demand and demand leveling by using behavioral-guidance models.

offering incentives such as discount fares or coupons for commercial facilities to modify service users' preferred departure times, thereby eliminating variations in demand. Furthermore, the provision of incentives and information to users raises expectations for results such as promoting use and revitalizing communities in addition to the stimulation and creation of potential demands (**Figure 5**).

5.4 Linking operation log data with other services

Operation log data of on-demand transportation services are stored in the database in real time. Some local governments make use of operation log data to evaluate the revitalization of local communities. Operation log data is linked with medical prescription data–itemized statements of medical expenses–for long-term quantitative verification of the effects of reducing local governments' medical expenses brought by the support of elderly people to go out. In future, we intend to link this service with the My Number System (individual number system in Japan) and electronic medical records. In this way, we aim to automate measuring the effects of introducing the service and establish the service as part of the regional basic infrastructure for daily life.

6. Conclusion

This paper presented features of the SPATIOWL On-Demand Transportation Service's operation plan creation that complement regional public transportation and the direction of the development of the service.

Currently this service is deployed mainly in provincial cities faced with issues of providing the community residents with means of transportation. We are also working on building a cooperative society by promoting the effective utilization of idle assets in communities (such as vehicles and drivers) and extra time of individuals (volunteers). In the future, to provide an even more community-oriented service, we will make use of the IoT, Big Data, AI, and blockchain technologies to link with basic daily life services and offer it as a linking service.

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