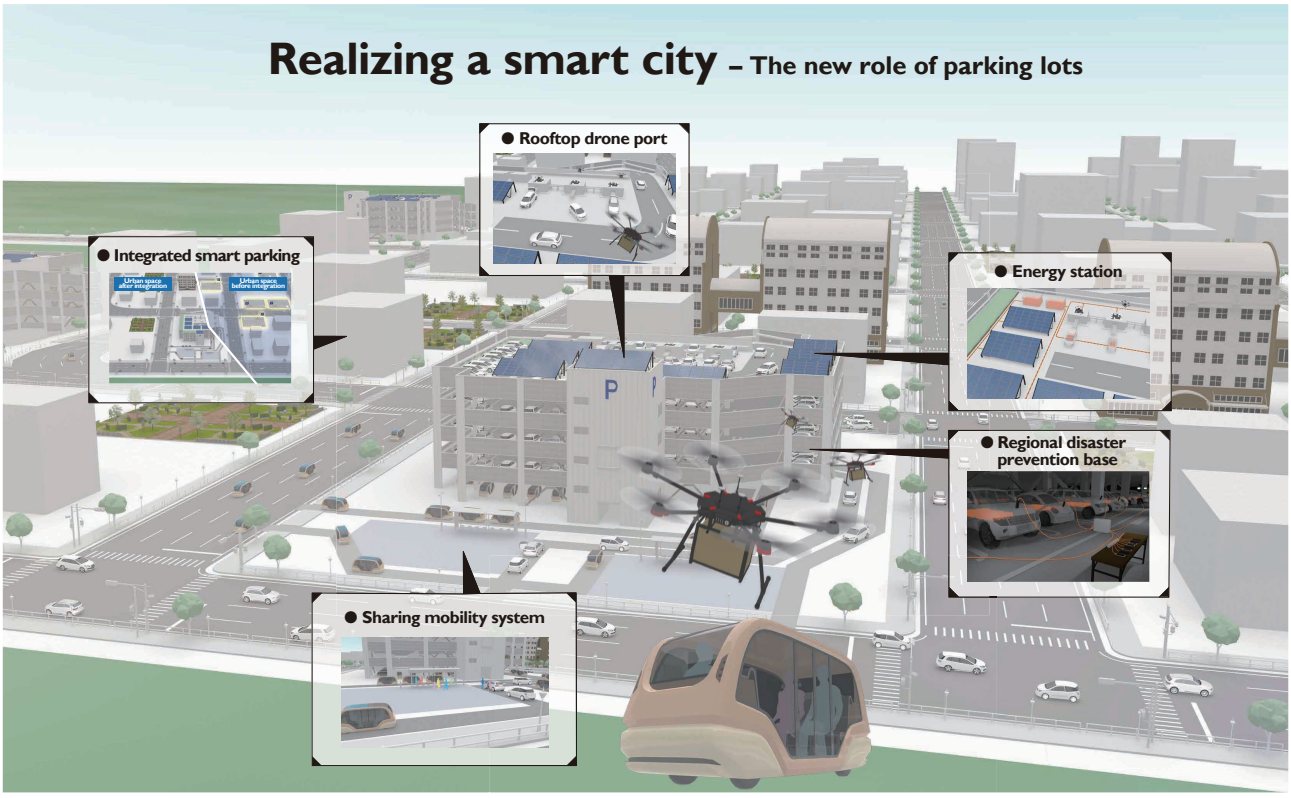
Shifting from Parking Spaces to Social Infrastructure

Delivering multifunctional drive-in multistory parking lots

Parking lots are no longer merely a space for parking cars but are becoming part of the social infrastructure. This article redefines drive-in multistory parking lots and introduces our efforts to respond to shift in parking lot policy.



Conceptual image of a smart city

Ever changing parking lots

In Japan, parking lots are at a major turning point. The number of automobiles owned is leveling off after a peak of approximately 80 million, but the number of parking lots available is growing steadily. As a result, the number of parking lots with low utilization is increasing nationwide. The 'Parking Policy Guidelines on Community Building,' released by the Ministry of Land, Infrastructure, Transport and Tourism in July 2018, focuses more on transforming parking lots into other facilities, and making effective use of existing parking lots rather than promoting the construction of new parking lots, showing a clear shift in parking lot policy.

Amid such shift in the policy, we are now required to change the function of parking lots even though so far we have been required to increase the number of parking lots. More specifically, it is necessary to develop a business model that provides epochal added-value facilities and social infrastructure beyond parking lots, which have been merely a facility for parking cars, in order to meet rapidly changing social needs.

Regarding parking lots as social infrastructure, IHI Transport Machinery Co., Ltd. has redefined its business framework, shifting from supplying parking lots to contributing to realizing a smart city, and has begun efforts based on the new business framework. First, we constructed a drive-in multistory parking lot (a three-story parking lot that can accommodate 110 cars) as a test facility our factory site in Numazu, Shizuoka Prefecture and began various

Demonstration test parking lot in Numazu

demonstration tests. The following introduces our efforts focusing on these demonstration tests.

Parking lots that serve as disaster prevention and regional energy-supply station

There are two important perspectives in order for parking lots to become new social infrastructure in future city building: ① disaster prevention and mitigation and ② environment and energy.

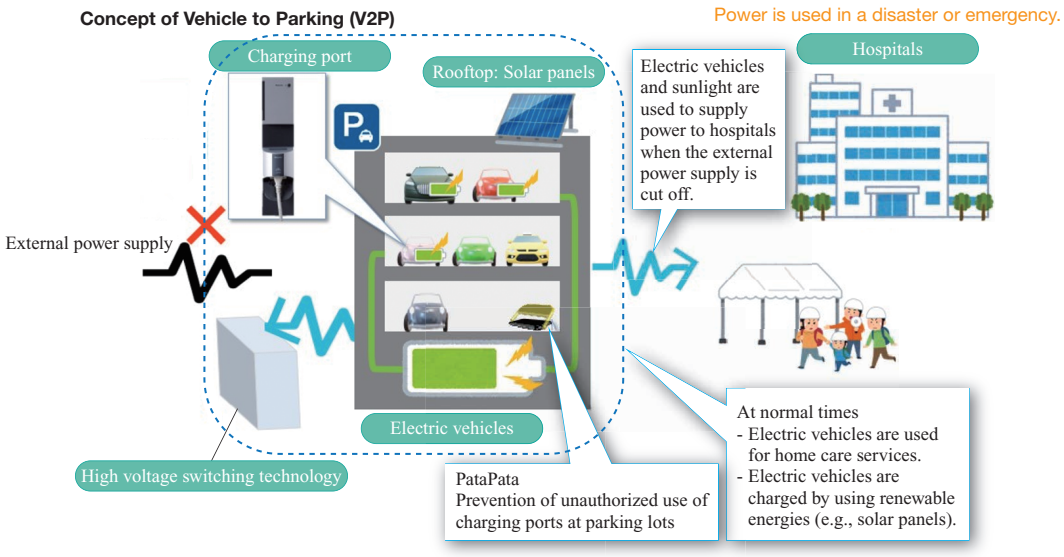
With regard to ① disaster prevention and mitigation, multistory parking lots, which do not have exterior walls but are open to the outdoors, are resistant to disasters such as typhoons and tsunamis because water goes through them. In addition, multistory parking lots have slopes, which allow those with baby buggies and wheelchairs to evacuate easily, and have enough space for many people to evacuate, making them able to fulfill their roles as temporary shelters. The demonstration test parking lot in Numazu was highly evaluated for its structural characteristics, and we signed the 'Disaster Agreement on Support and Cooperation' with Numazu City in November 2018. On September 1, the National Disaster Prevention Day in Japan, a disaster drill was conducted involving approximately 300 local residents in 2019. It was covered by the local newspaper and received a strong response, demonstrating the effectiveness of the facility. We will plan local events for more people to recognize this facility and hear opinions from the participants, and continue its development and improvement, always from the perspective of the local residents.

With regard to ② environment and energy, owing to the spread of electric vehicles, parking facilities that have many spaces for parking electric vehicles could serve as regional energy-supply stations. The rooftops of multistory parking lots are good places for solar, wind, and other renewable power generation. If provided with batteries in unused spaces, drive-in multistory parking lots could have the functions of charging electric vehicles and of reducing the electricity costs of the parking lots and facilities around them by means of power peak-cut control. Moreover, in case of an emergency, they could have the function of supplying electricity from the electric vehicles to the nearby facilities such as hospitals.

We are developing a renewable energy infrastructure package that combines solar panels, batteries, and a power conditioner into one unit. Also, we are developing an energy management system that can connect with multiple electric vehicles and remotely operate the input and output of electricity.

Parking lots for mobility

Because of technological innovation, mobility is facing the greatest change in a century. As automobiles replaced horse-drawn carriages in less than ten years on 5th Avenue in New York at the beginning of the 20th century, a whole new type



Energy management system under development

of mobility may replace the automobiles we now use every day in a few years.

When such a future becomes more realistic, parking lots will be required to change their appearance. We are conducting research and development on the following subjects to keep track of and predict the trends in next-generation mobility, such as autonomous driving vehicles, flying vehicles, ultra-compact electric vehicles, and community bicycles, and social changes brought about by technological innovations, such as AI and 5th-generation mobile communication system (5G).

(1) Incorporating autonomous driving and image analysis technologies

To obtain knowledge about multistory parking lots that are compatible with autonomous driving, we conducted joint test runs of autonomous driving vehicles with Manabu Omae, Professor of Keio University. As a result, for the first time in Japan, we established the technology for autonomous driving and parking in closed spaces, such as multistory parking lots and mechanical parking lots, by enabling a vehicle to recognize its own location only using vehicle-side optical sensors, that is, without using GPS location information.

To operate autonomous driving vehicles, a 3D map is required. Almost all the expressways in Japan have a 3D map in place for the future era of autonomous driving. We developed a technology to acquire a 3D map of a multistory parking lot, and succeeded in allowing vehicles to drive autonomously in a 3D structure, which typically consists of multiple stories connected to one another, for the first time in Japan.

Today, when a driver uses a mechanical parking lot, they have to park and get in and out of their car inside the parking lot. In the future, however, they can get in or out at the entrance of the building, which would provide enhanced convenience and in addition, contribute to preventing accidents in parking lots, such as being caught in the equipment.

We are considering further developments. For example, the combination of autonomous driving, 5G, and image analysis would bring about a drastic change in the concept of parking availability. If autonomous driving vehicles can park autonomously, space for getting in and out of vehicles is no longer necessary, enabling efficient parking with minimum clearance between vehicles. In addition, no markings are necessary for parking spaces as the driver no longer needs to check the markings visually when parking. At the demonstration test parking lot in Numazu, the image analysis technology has already been employed to recognize parked automobiles and motorcycles as 'objects used to fill gaps,' with which we are conducting tests aimed at achieving the most efficient parking.

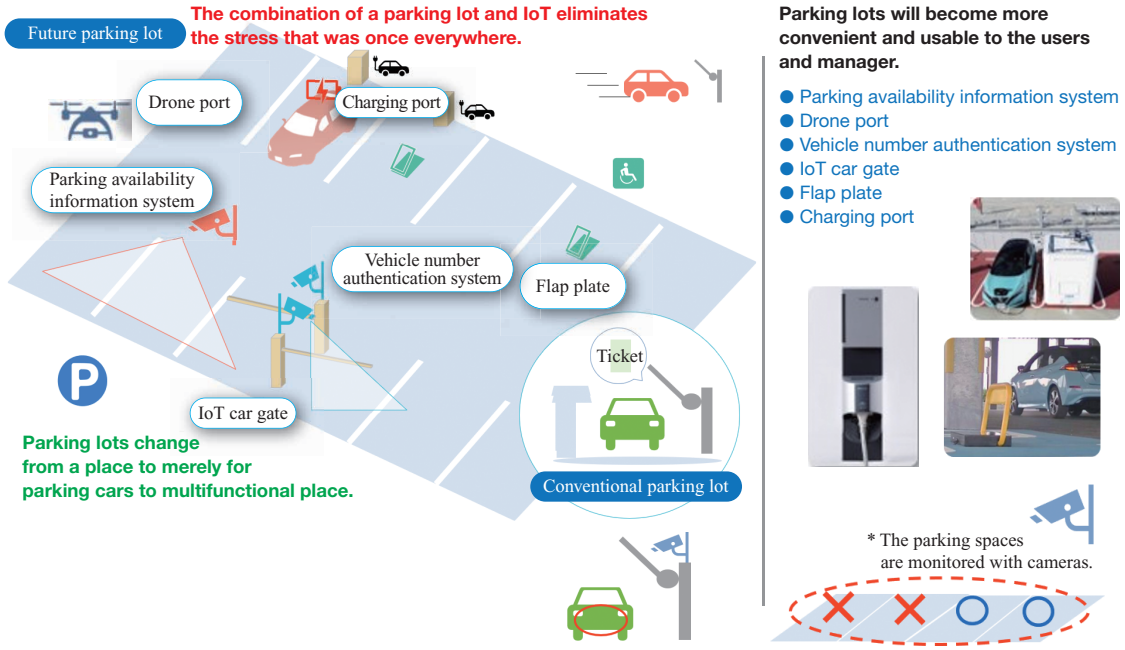
(2) Development of drone ports

As previously mentioned, existing parking lots have an increasing number of vacant spaces, and in particular, the rooftop space of a multistory parking lot is unpopular, so it does not bring much revenue to the owner and may lead to social opportunity loss. Therefore, we are conducting research aimed at using the rooftop space of a multistory parking lot as a place for drones, which are a recently emerging transportation device, to take off and land. More specifically, the rooftop spaces are used as cargo handling facilities or logistics bases in conjunction with autonomous driving vehicles. First of all, we are considering the possibility of using a parking lot as a facility for drones to take off and land for transporting goods in combination with the parking lot's functions as a shelter and a place to ship, receive, and store relief supplies in case of a disaster.

In recent years, large natural disasters occur every year throughout Japan, and we often see news that a road is closed by a collapsed building, landslide, or collapsed bridge, and as a result, a shelter is isolated. According to the thesis written by Satoru Kobayakawa, Professor of Department of Transportation Systems Engineering, College of Science and Technology, Nihon University, a simulation result revealed that if a large earthquake occurs in Tokyo, nearly 10% of shelters in an area densely crowded with wooden houses would be isolated mainly by collapsed buildings. This means that reliable transportation of goods to shelters in a disaster is a very important issue both in urban and rural areas, and using

Parking availability information system monitoring with web camera

Drone port for logistics drones



Schema of IoT parking lot

drones could be one solution.

Focusing on drone ports for logistics drones to take off and land, we jointly developed a prototype with Blue innovation Co., Ltd., and succeeded in unmanned loading of cargo from drones to autonomously driven vehicles for the first time in Japan (more specifically, from drone landing control to receipt, temporary storage, and loading of cargo to autonomously driven vehicles). The drone landing accuracy is expected to increase with technological innovations. We will design and produce smaller and more convenient drone ports and conduct demonstration tests with local governments mainly based on the transportation of goods in a disaster.

Incorporating technological innovations into parking lots

We are also aiming to achieve improved user convenience and labor-saving parking lot operation by using IoT for parking lots.

One demand from parking lot users is to enter a parking lot without congestion after arriving at their destination, and to park their car with ease. On the other hand, one of the demands from parking lot operators is to be able to guide the user to a parking space and manage the parking spaces without manual intervention. For parking lots in commercial facilities, there is a demand to collect marketing information (e.g., where visitors come from, how often they visit) from the automotive license plate information and issue coupons to encourage people to come again. To meet these demands, based on the IoT platform we developed (Box as a Service: BaaS), we are offering unique services in combination with the vehicle number authentication system, parking availability information system using Web cameras, the IoT car gate (aQmo), the flap plate that allows only specific users to reserve and use parking spaces (PataPata), and the charging port for electric vehicles that can be operated remotely. We are offering these solution services at reasonable prices even with the same level of quality as competitors, targeting existing parking lots that have had difficulty in introducing such services.

So far, we have delivered drive-in multistory parking lots merely as a facility for parking cars but will be developing solutions in a short time by combining BaaS which we developed, with technologies developed by venture companies, transforming parking lots in response to social changes and delivering unique services through IoT parking lots.

Shifting our focus from vehicles to people

IHI Transport Machinery, which is currently merely a provider of parking spaces, will continue research to answer the question “How can we add value essential as social infrastructure to parking facilities?” and at the same time, conduct interviews with parking lot owners to find out their demands to keep their parking lots valuable. Under the slogan ‘Shifting our focus from vehicles to people,’ we will develop parking lots, which serve as a first contact area for people who visit a town, into social infrastructure that can meet these demands.

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