Mori Building 5G Plan

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1. Communication as urban infrastructure

Cities are formed according to the major types of infrastructure of the era. The major infrastructure contributing to the structure of modern cities is roadways. This is so obvious that modern people are scarcely aware of the fact that all homes face a roadway and people and goods move on these roadways, which support people's lives and activities in cities. In the outskirts of cities throughout Japan, all kinds of shops can be seen along main roadways.

Another infrastructure supporting cities is railways. Rail lines stretch across major cities like a mesh and help to move people, even in medium-sized cities. Railways were the main type of urban infrastructure in Japan before automobiles became widespread in the late 1960s and early 1970s. There were railway stations in the center of cities where people would gather, with department stores and shopping areas nearby. When automobiles become widespread, the weight of urban infrastructure shifted from railways to roads, and shopping centers and other commercial facilities in inner cities began to suffer while shopping centers began to flourish in suburban areas.

For a long time before railways appeared, a main infrastructure supporting cities was not railways or roads, but waterways. Evidence that waterways were a primary type of infrastructure for towns can be seen throughout Japan. Let's look at two examples.

Figure 1 shows an Edo period riverside fish market near what is now Muromachi1-chome in Nihonbashi, Tokyo. Shops lined the sides of the waterway, and many boats came and went carrying goods. Such scenes continued until World War II. In Edo towns, waterways were heavily relied upon for the distribution of goods, so they were lined with many stores. Tokyo's waterways have since fallen into the background, but they were firmly at the forefront during the Edo period.

Figure 1: Late Edo period riverside fish market (near current Muromachi 1-chome, Nihonbashi Tokyo). From "Famous Places in the Eastern Capital: *True View of Nihonbashi Bridge, Together with a Complete View of the Fish Market (Nihonbashi shinkei, narabi ni uoichi zenzu), from the series Famous Places in the Eastern Capital (Tôto meisho)*

The other example that waterways played an important role as infrastructure is Itsukushima Shrine (Figure 2), which is a UNESCO World Heritage Site.

Figure 2: Itsukushima Shrine

Itsukushima Shrine, said to have been built during the era of Empress Suiko in around 600 AD, is famous for its "floating" torii gate. The torii gate is on the approach to the front of a shrine, and its location in the sea meant that the waterway was the formal entrance to the shrine and therefore the formal approach for worshipping was done by boat. The reason for worshippingby boat can be understood by looking at the local shipping routes at the time (Figure 3).

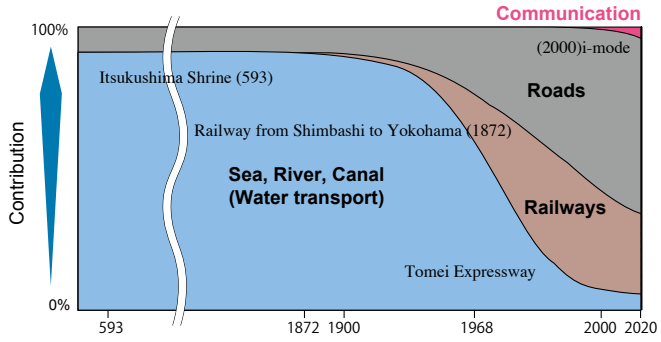
Figure 3: ajor shipping routes of Inland Sea during Tenpyo Era (around 750 AD). Based on "Ancient states and transportation on Seto Inland Sea," Hironobu Matsubara, 2004.

At the time, the inland sea was a major artery for the movement of people and goods, connecting ancient Nara, the Chugoku, Shikoku and Kyushu regions, and even the Korean peninsula.

In current terms, it was equivalent to an expressway. Ships traveled this "expressway," so the location of Itsukushima Shrine on this important route was like a service center on a modern expressway, which is why passing ships would stop to visit the shrine.

As such, waterways constituted the main infrastructure for cities from the Asuka era through Edo and into the Meiji era, but this role gradually shifted to rail during Meiji and then began shifting to roads in the Showa era. This is illustrated in Figure 4.

Figure 4: Rates of contribution to urban infrastructure



Telecommunications appeared as infrastructure in the 1990s, and we can now see now how communication infrastructure has impacted cities. From the time when telecom carrier DOCOMO launched its i-mode mobile internet service in Japan in the late 1990s, the purchase of goods through the internet has increased continuously. According to Japan's Ministry of Economy, Trade and Industry, sales of goods through the internet in 2018 reached one billion yen, or over half the sales volume of department stores and supermarkets (1.94 billion yen).

Before sales became possible through the internet, people made purchases at physical stores, which made such stores absolutely necessary. This is not necessarily the case now, and as a result, physical stores, including commercial areas around train stations and in suburbs, have begun to decline. This is resulting in changes in the structure of cities, including the further decline of commercial facilities around train stations and the thinning-out of suburban shopping areas.

2. Infrastructure's impact on city formation

So far, we have examined changes in urban infrastructure, including waterways, rail, roads and telecommunications, but the impact of telecommunication on cities is very different from that of waterways, roads and rail, so it is expected to greatly change the direction of city formation.

Waterways, rail and roads are infrastructure for transporting physical things, including people and goods. Of course, information is also transported by people, but this is a secondary effect.

Telecommunication is very different because it moves information entirely independently of a physical process, and this has exactly the opposite effect on cities. Moving physical things efficiently requires reduction of distances and time, which results in the formation of more centralized and highly concentrated cities. Centralizing everything as much as possible increases efficiency. Conversely, rather than concentrating information in one place, efficient transmission of information is achieved through sharing. Information is more efficient when people share the same information, and having information in only one place is not efficient. The effect on city formation is decentralization, which is opposite to the effect of waterways, rail and roads (Figure 5).

Figure 5: Effects of urban infrastructure

Urban Infrastructure	Transport Items	Measure of Efficiency	City formation
Roads	People	Efficiency = Concentration Reduction of travel Distance Reduction of travel Time	Centralization
Rail	Goods		
Waterways	Information		
Telecom	Information	Efficiency ≠ Concentration ≒ Sharing	Decentralization

Until now, this effect has not been particularly striking or noticeable to people, but the COVID-19 pandemic instantly brought it to the forefront. Before COVID-19, people were aware of the ideas of telework and web meetings, but few had any opportunity to actually participate in such activities, nor did they think that such methods were truly practical. Now, telework and web meetings have permeated society in one fell swoop, prompted by COVID-19. The immediate switch to telework is evidence that telecommunications as infrastructure has permeated society, but telework itself has also changed the way people think about where to live. It has created the possibility of being decentralized in suburbs or other regions rather than being centralized in cities, unlike in the recent past. With fewer commutes into the city and more time spent at home, employees are beginning to focus more on the quality of their home environments and less on their commute times. As a result, people are considering moving to the suburbs or regional communities where they can live in better environments with roomier homes. In fact, according to the Report on Internal Migration in Japan from the Ministry of Internal Affairs and Communications' Statistics Bureau, people began moving out of the 23 wards of Tokyo around May 2020 and since that August, almost 5,000 people per month have been exiting cities. The most popular destination has been Kanagawa Prefecture, south of Tokyo, followed by Saitama Prefecture, north of Tokyo.

Similar trends have been observed overseas, such as reports of homes with gardens outside of London becoming more popular.

However, it does not mean that this trend will persist and people will continue to move out of large cities, making cities decline further. Humans exist in the physical world, so urban infrastructure, including roads and railways, will remain essential and focused on centralization. In the future, therefore, the forces of centralization and decentralization can be expected to compete and over time they likely will reach some form of equilibrium.

3. What is required of communication?

Telecommunications now occupies an important position as urban infrastructure, but it has come upon the scene relatively recently and its functionality has not necessarily reached its full potential yet. In fact, the current functionality and capabilities of telecommunication are said to be inadequate.

Urban infrastructure, including waterways, rail and roads, share the essential role of distributing goods. Waterways transport large volumes of goods over long distances, rail transports large numbers of people at high speed, and roadways transport smaller numbers of people and goods but with the flexibility to reach locations that waterways and rail cannot. As such, the combination of these three types of infrastructure meets various types of demand. With telecommunications, however, relatively few types of service are available to users and the services themselves do not differ among mobile carriers. If a user wants to utilize telecommunication in an uncommon way, the options are very limited.

As an example, many people have experienced the problem of unstable communication when engaged in telework or a web meeting. During COVID-19, people have been taking part in web meetings increasingly more often, and anyone who has done so will have surely experienced someone in a meeting losing their connection or their image freezing. Of course, a large part of this is the communication bandwidth of the service being used, but basically it is a problem of speed. Generally, communication is provided with speeds on the uplink (transmitting/uploading) and downlink (receiving/downloading) in a ratio of roughly 1:2, with priority given to the downlink. This is because when people use the internet, they generally look at websites or video, so priority is given to the downlink. This is how communication environments are configured at present. For a web meeting, users are also transmitting video of themselves, so a speed ratio of 1:1 would be desirable, but carriers do not offer such a choice and users are left with only 1:2 services.

Next, let's consider the growing use of sensors and other IoT devices in production sites. In facilities such as plants and factories, IoT devices for measurement and control are being installed to increase production efficiency, but wireless communication systems are not optimized for this task. Installing optical or other cables would be the most reliable method, but most factories are large and various locations must be tested before deciding where to install IoT devices, so costs and time make cables impractical. With Wi-Fi, however, latency cannot be guaranteed and communication can be interrupted when there is congestion. Also, on-site IT specialists are needed to maintain security at all times, but this is not practical for most companies. There are carriers that provide guaranteed latency and high-security communication, but these are expensive. In the end, there is no practical choice.

Meanwhile, telecommunications services currently provided to homes and industrial buildings such as factories do not offer the necessary range or types of functions essential for serving as basic infrastructure.

Services that can overcome such limitations include local LTE (4G) and local 5G. In particular, local 5G provides the capabilities required by industry, including ultra-high speed, low latency and massive simultaneous connections. It also offers strong security through the use of changeable SIM cards. Further, users can flexibly realize desirable communication environment with the use of advanced technologies such as slicing.

Telecom carriers now fulfill the role of seamlessly connecting the entire country, similar to waterways, rail and highways. If local 5G could handle the last mile from main lines to homes, enabling users to freely configure various services, telecommunications will be able to guarantee the functionality and freedom required to be considered a genuine urban infrastructure.

4. Local 5G and Mori Building

As shown, local 5G is a technology capable of supporting and even transforming activity in cities, as urban infrastructure. Mori Building is now considering deploying local 5G to create communities where people living and working in cities will be able to enjoy tremendous convenience in their lives and work.

Communication nodes linking telework and satellite offices

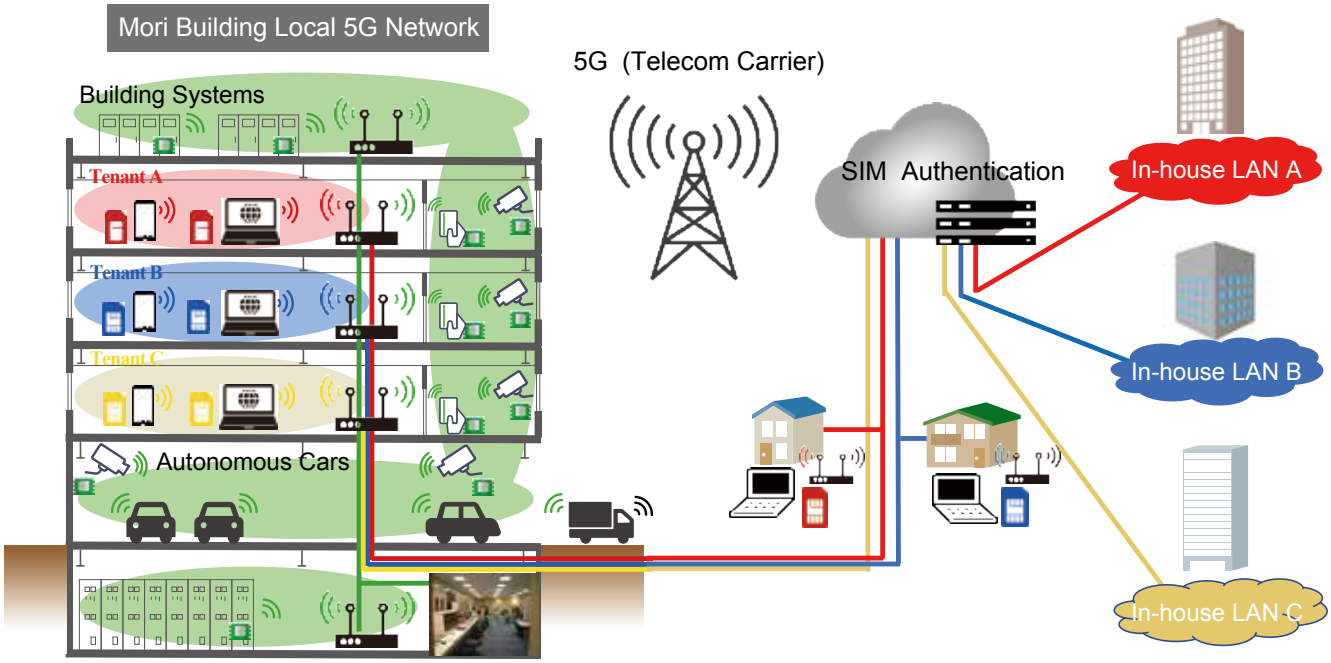
Whereas the COVID-19 pandemic is expected to wind down eventually, we have seen that telework is possible in a practical sense, so it is expected to continue to be used. That said, this does not mean that offices in city centers will disappear. But how this new form of telework will be integrated with existing ways of working in offices will need to be considered carefully.

Part of the challenge will be to provide opportunities for "five-sense" communication, something that has been diminished by telework. With telework, it is difficult to feel beyond words, with all five senses, as we can when communicating with someone in person face to face. Subtle nuances, such as atmosphere, gestures and even handshakes, can be lost in digital communication. It is said that in enterprises, new business ideas often arise in lively discussions among people in a room or during idle talk among colleagues. In the future, there will be a need for the kind of five-sense communication that is possible when people gather in a downtown office but not during telework. Mechanisms and environments to make this happen will be needed.

One prerequisite for this will be communication nodes with the functionality to enable work and communication to proceed smoothly and securely between offices, satellite offices and telework locations (Figure 6).

Advanced security is necessary when handling important corporate information at homes, satellite offices and other external locations. Network management departments in every enterprise

Figure 6: Mori Building local 5G overview



make use of various technologies to maintain security, but when employees use these systems off-premises, as with telework and satellite offices, it can be practically impossible to manage all cases. It is also difficult for employees working externally to perfectly perform the many and often complex security procedures required. As such, it is becoming necessary to incorporate local 5G into business, enabling companies to control their own communication and provide advanced security by only using SIM cards. With this solution, as long as local 5G is deployed in the main, satellite offices and other locations such as resorts or "workation" spots, every company can ensure highly secure communication among internal locations, work can be done safely and the company intranet can be accessed securely from any of these locations.

The same measures will be deployable for telework by combining local 5G with a carrier's roaming mechanism. One day it likely will be a standard practice to install local 5G base stations in downtown offices.

Self-driving valet services for building parking

The appearance of self-driving vehicles in cities will have a huge impact. Less-mobile people suddenly will be able to go anywhere they want, whenever they want, and with fewer traffic accidents than at present. An example of this phenomenon will be self-driving in building parking lots. With this technology, drivers will be able to leave their vehicles at building entrances and the vehicle will proceed to a parking space on its own. If a time to return is set, the vehicle could be ready and waiting at the appointed time, similar to a hotel valet service, at any building.

Shopping facilities lose sales opportunities due to customers waiting to enter parking areas during holidays and other busy times. If this same time could be spent inside, sales would likely increase. If self-driving technology were available in office buildings and apartment buildings, parking areas would no longer need to be within a building itself, since available spaces nearby also could be used for parking.

Establishing this technology will require the introduction of local 5G. Inside a building, where GPS is not available, it is difficult for a self-driving vehicles to determine its location. Local 5G would enable a building to communicate with self-driving vehicles to provide information on building access, the parking-lot entrance, lanes within the parking lot and available spaces for parking, allowing vehicles to operate indoors without a need for AI. Local 5G, with its advanced security and low latency, will enable this to become a reality.

The deployment of local 5G is also being considered for handling sensitive information in residential facilities, for supporting healthcare management through the use of sensors, and for providing added-value conveniences to building residents.

5. Conclusion

Local 5G technology will provide customized communication services beyond those provided by carriers at the present time, and in user-friendly formats. It will require communication carriers, vendors and users to collaborate to make this technology even better. If this can be done, the promise of safer and more convenient cities would appear to be possible.