Formation of Information Transfer Methods for Envisaged Disasters

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ABSTRACT

After the occurrence of the Great East Japan Earthquake on March 11th 2011, an unprecedented confusion occurred around the Tohoku region, because of the stoppage of communication infrastructure due to the interruption of network lines, power cuts, etc. In the City of Yokohama, too, it became difficult to transmit information due to connection restrictions of general and mobile phones. Because of this, Yokohama Waterworks Bureau had difficulty assembling staff, grasping the extent damage of its facilities, and sharing information amongst branch offices.

We consider that in order to carry out recovery activities of water supply swiftly in all the areas of the City of Yokohama at the time of similar disasters in the future, ensuring reliability of means of information communication across the headquarters of Yokohama Waterworks Bureau and its branch offices is important. Therefore, we have constructed a means of information communication to be used in the Waterworks Bureau with a consideration of economic factor about which we report here.

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Communication Status in the Affected Area

Figure 1 shows the initial status of communication in the affected Tohoku region.

In the disaster-stricken Tohoku region, buildings for transmission and facilities provided by a telecommunication carrier (NTT) were damaged, and also, the damage expanded to storage batteries, which are power sources in emergency, running out due to the prolonged period of commercial power failure. Because of this, with regard to landlines and optical lines, a maximum of 1.5 million lines were stopped, while for mobile phones, a maximum of 7,000 or a little less radio stations were suspended. Also, since the network was over capacity as a large number of people made calls using mobile phones, telecommunication companies implemented connection restrictions to protect circuit switching facilities. Then, about 10 days were required for the recovery of about 80% of facilities.

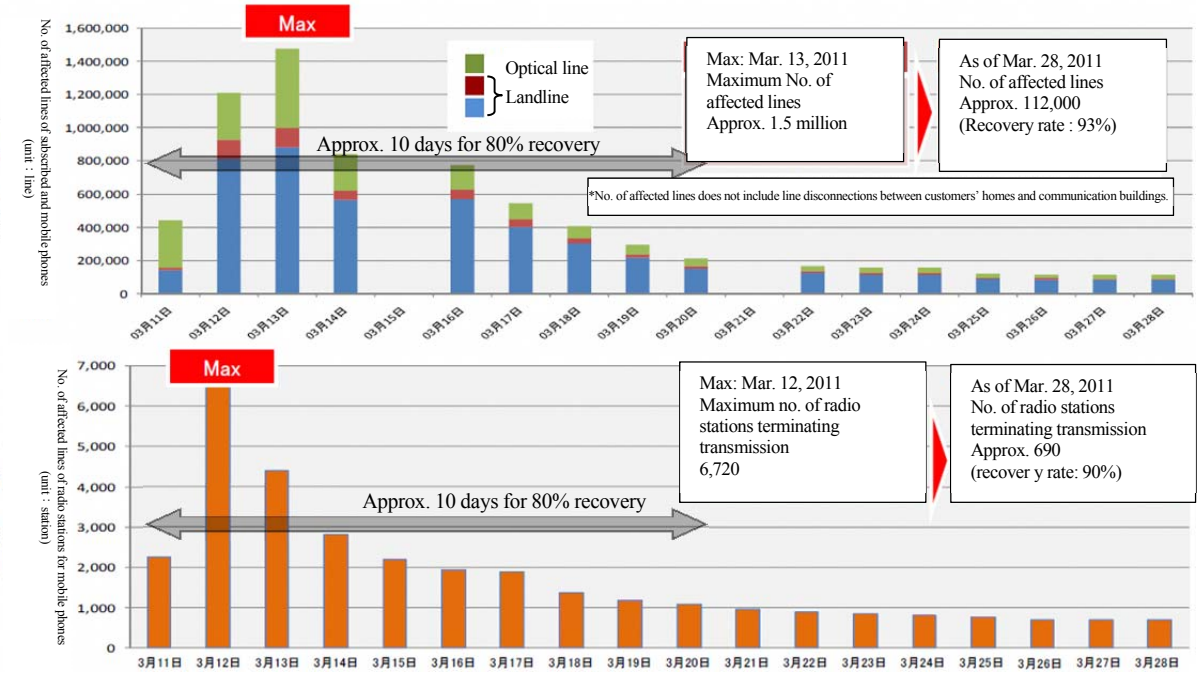

Figure 1. Communication status in the affected area due to the Great East Japan Earthquake (Source: data created by NTT)

Means of Information Transmission of Yokohama Waterworks Bureau

Table 1 shows an existing means of the Yokohama Waterworks Bureau. In order to convey information promptly even during a disaster, various communication facilities were developed and they were utilized according to their features. However, each of them had problems on their use. Especially, right after the occurrence of the disaster, the communication status became like that of the affected area, and swift information communication between branch offices could not take place sufficiently.

Table 1. Conventional means of communication

Equipment Image	  (Landline phones) (Mobile phones)	  (Portable) (Semi-fixed)	
Name	(1) Landline, mobile phones	(2) Disaster prevention administration wireless equipment	(3) Satellite mobile phones
Installed place	Placed multiple phones in each office	Placed them in each office and cars	Placed them in each government office building
Features	Owned not only by Waterworks Bureau, but also by other corporations and individuals, and have versatility.	210 units are possessed by Waterworks Bureau, and almost 1000 units are owned by the City of Yokohama.	Mobile phones that use artificial satellites, and have versatility.
Problems	Approximately 10 days are expected to be required for 80% recovery from disaster. It is all but impossible to use mobile phones right after the occurrence of a disaster due to connection restrictions. Reliability of communication depends on telecommunication carriers.	Since the whole Yokohama Bureau shares communication lines, if the network is over capacity, control regulations are exercised and Waterworks Bureau can use only 1 line.	One satellite mobile phone is placed in each office building of Waterworks Bureau. In a state of confusion, it is difficult to communicate a large amount of information.

Development of Waterworks Bureau's Original Wireless Communication Network

We have been developing a communication network that utilizes the 5GHz band wireless access system (hereinafter called 5GHz band FWA (Fixed Wireless Access)) as a new means of information communication since fiscal 2013, with a goal of constructing "a reliable lifeline that is resistant to disasters". Figure 2 shows its outline.

In fiscal 2013, the Head Office Building of Waterworks Bureau and Nishiya Purification Plant were connected using this 5GHz band FWA. Due to this, using extension telephones, fax, and data communication with computers for business use within the Waterworks Bureau were made possible without involving any telecommunication carrier.

Later in fiscal 2015, the Head Office Building, Nakamura Waterworks Office, Nishiya Purification Plant and Kikuna Waterworks Office were connected, and by coordinating with the existing Wireless Monitoring Network for Water Purification Plant (7.5GHz band micro wireless), a wireless communication network connecting 8 office buildings in Waterworks Bureau was developed. Figure 3 is a structure chart showing that, and figure 4 shows the positional relationships of offices.

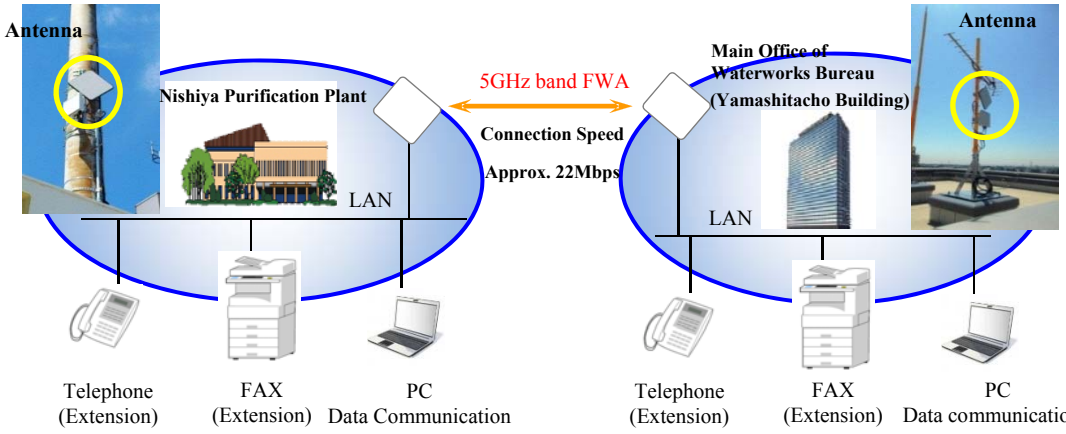

Figure 2. Outline of a communication network utilizing 5GHz band FWA

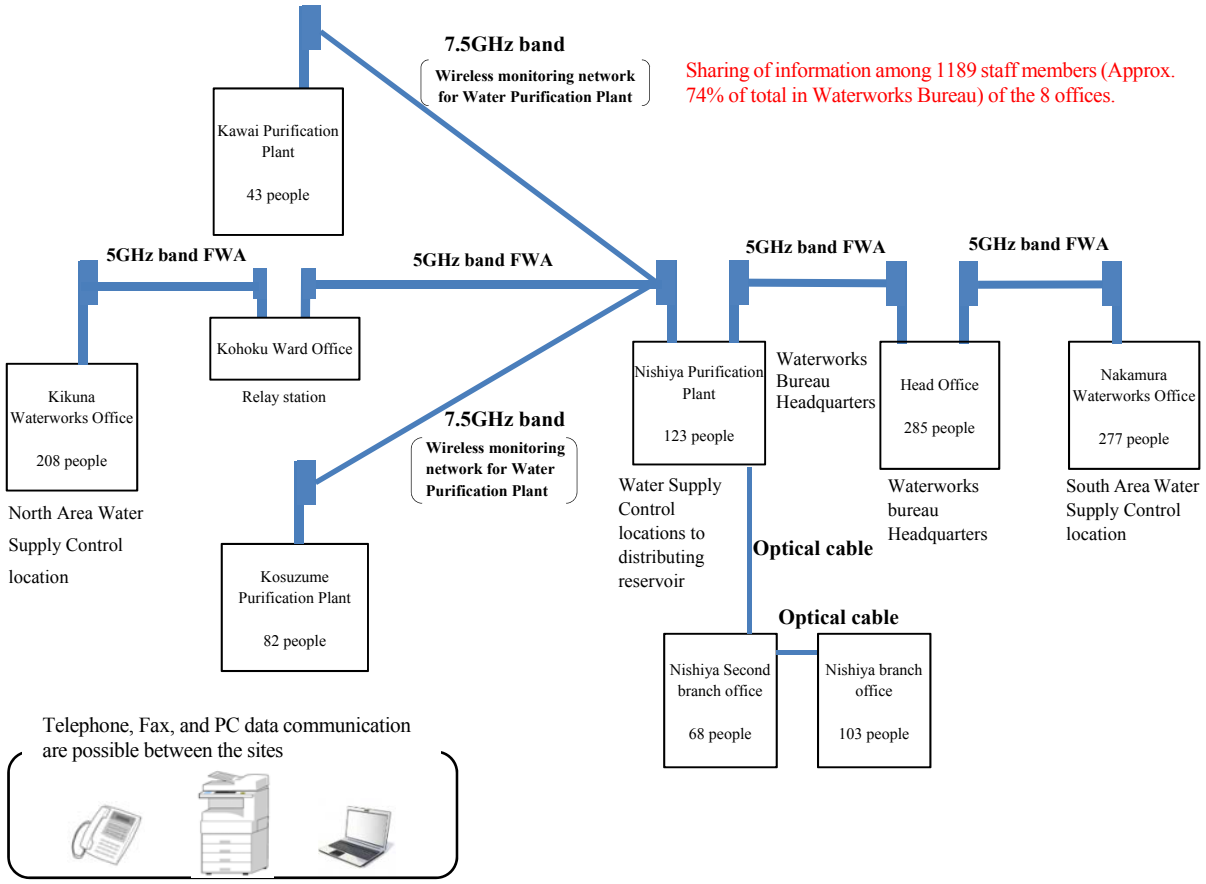

Figure 3. Structure Chart of Wireless Communication Network in Yokohama Waterworks Bureau

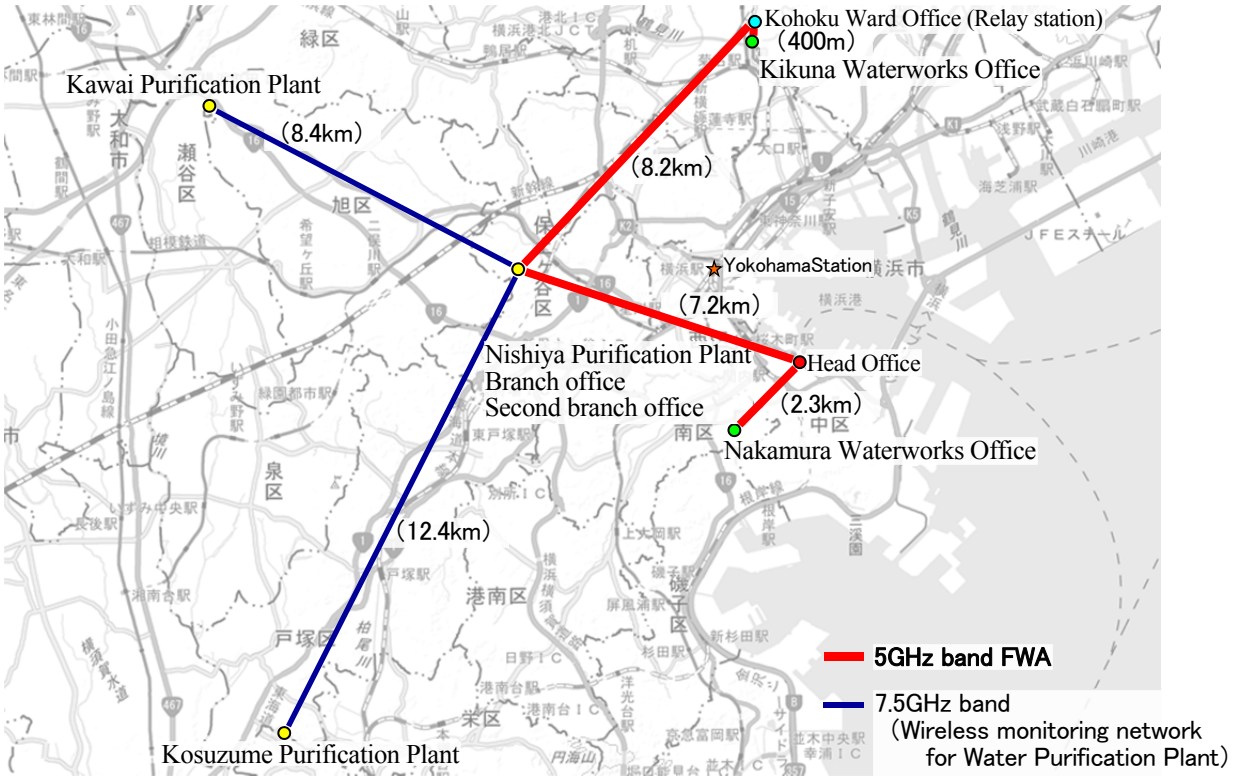

Figure 4. Positional Relationships of offices of Yokohama Waterworks Bureau

Device Configuration and Features of 5GHz Band FWA

Device Configuration

Figure 5 shows the device configuration of 5GHz band FWA. It is a simple device configuration with only a square shaped (about 36 cm) antenna and a transceiver body (about 25 cm). Router and HUB are connected to the LAN interface of the transceiver body, and communication terminals such as a private branch exchange and a PC are connected there.

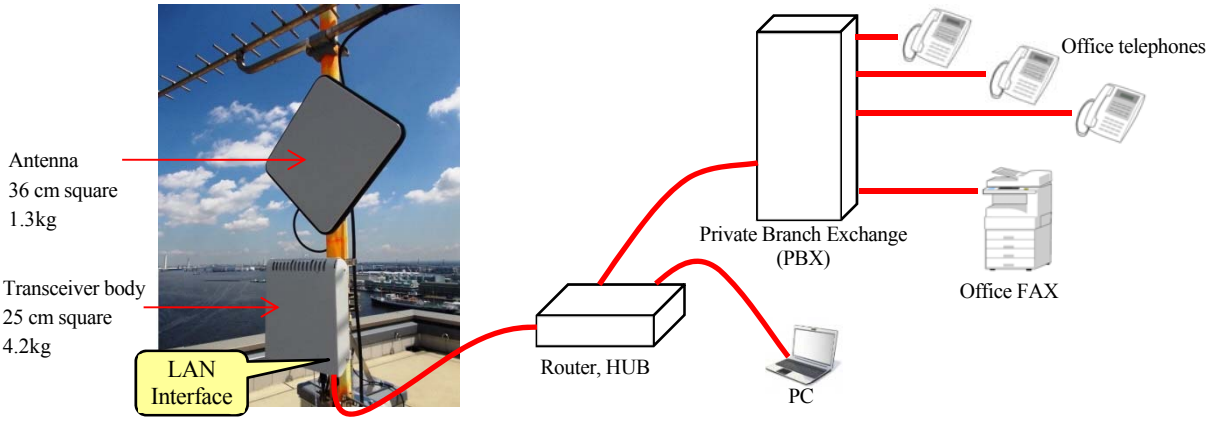

Figure 5. Device configuration and connection diagram of 5GHz band FWA

Features

The features of 5GHz band FWA are as follows.

- The transceiver body and the antenna are compact, and so they can be installed anywhere.
- Installation cost is low, about 1/5 of that for business use.
- Communication speed is so fast that the communication between the Head office of Waterworks Bureau and Nishiya Purification Plant (about 7.2 km) is possible at the speed of about 22 Mbps.
- Since it is a LAN connection, the exchange of data, audio, images, etc. is possible by connecting it with a PC, an IP-based private branch exchange, or a Web camera.
- Since it is an original communication line, it will not face network congestion as well as connection restrictions from any telecommunication carrier.
- Inside Japan, the screening for licensing has been simplified, therefore, it can be set up in about half a month after registration.
- As the signal is excellent in straightforward transmission, it is less affected by rain or fog, however, there's a need to install antennas in opposed directions in a range of one's view.

Effects of Installation

Secured a Communication System to be Used at the Time of Disasters

A communication network not dependent on a telecommunication carrier was constructed, and sharing of information among 1189 staff members of 8 offices (about 74% of total in Waterworks Bureau) was made possible.

Improvement in Easiness of Use

We developed a communication system that can function instantly at the time of a disaster by using regularly used telephones, FAX, or PC for business use without using a disaster prevention administrative radio or satellite mobile phone that is used in the time of emergency (Figure 6). In addition, when communicating among offices, intermediation is involved if an outside line is used, but an extension number can directly call a person, thus, its convenience has been improved (Figure 7).

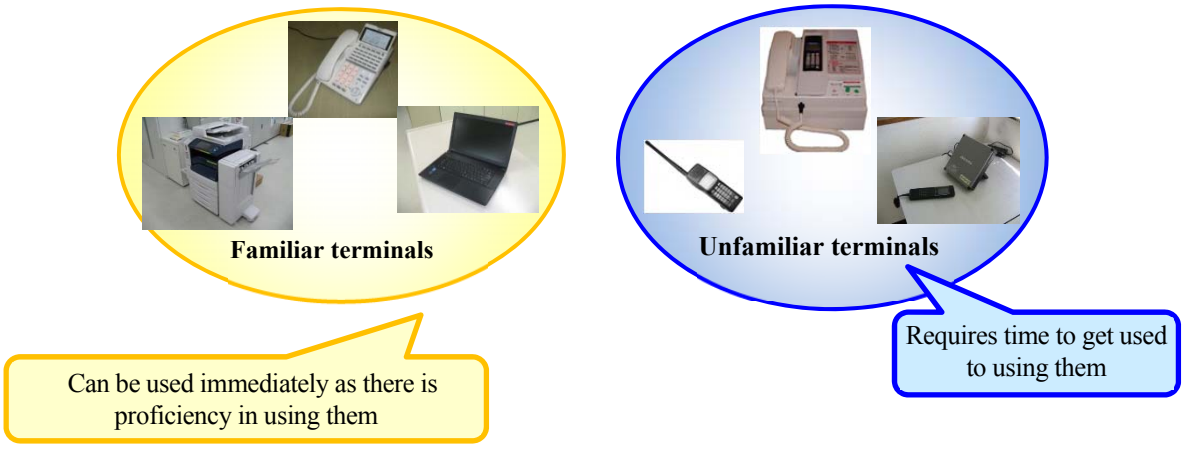

Figure 6. Impression of using terminals

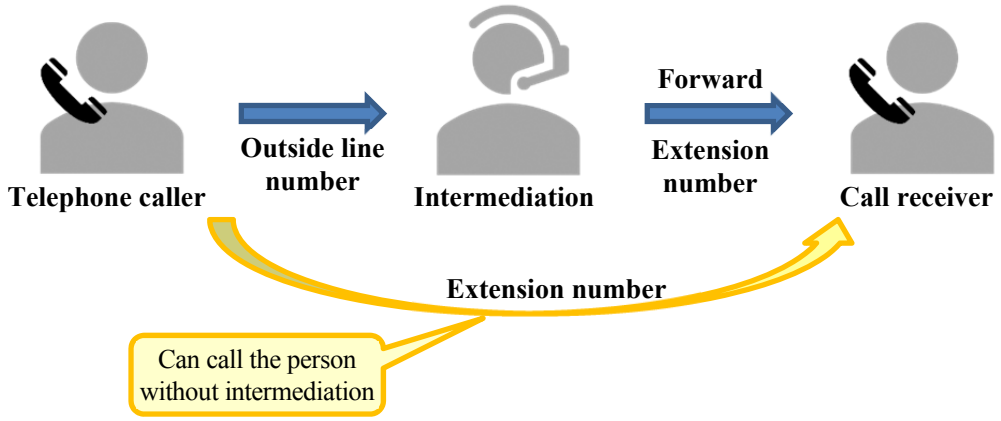

Figure 7. Image of call receiving

Reduction in Communication Cost

By using an extension line for business correspondence in place of outside line telephones that had been in use so far, communication cost was largely reduced. Approximately 16 years would be needed for full recovery of life cycle cost, which exceeds the 10-year service duration of the device, but the recovery of initial cost alone is possible in about 10 years. (Figure 8)

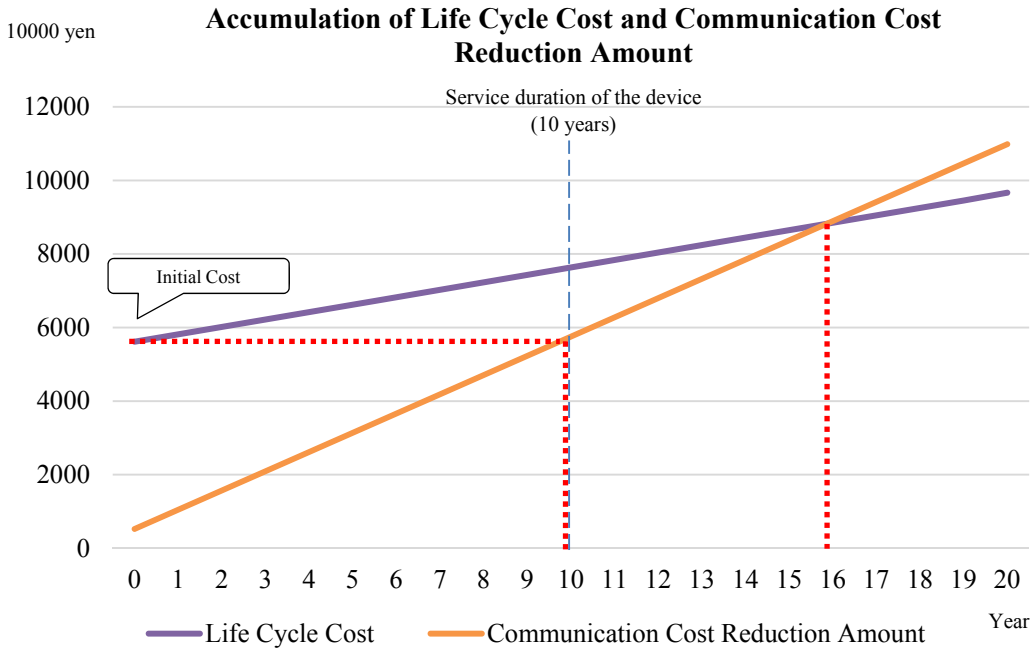

Figure 8. Accumulation of Life Cycle Cost and Communication Cost Reduction Amount

Conclusion

At the time of a disaster, the contribution to swift and definite activities for recovery of water supply facilities was made possible by effectively using this means of information communication. Also, further reduction in communication cost would be possible if each staff member actively uses extension lines for daily business correspondence.

REFERENCES

[1] Nippon Telegraph and Telephone Corporation, published on March 30, 2011, Damage from the Great East Japan Earthquake, its recovery status, and future outlook