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DEMONSTRATION EXPERIMENT OF LONG-DISTANCE WI-FI MESH NETWORK IN IITATE VILLAGE, FUKUSHIMA

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Equation quiz

$$\text{IoT} - \text{I} = \text{oT}$$

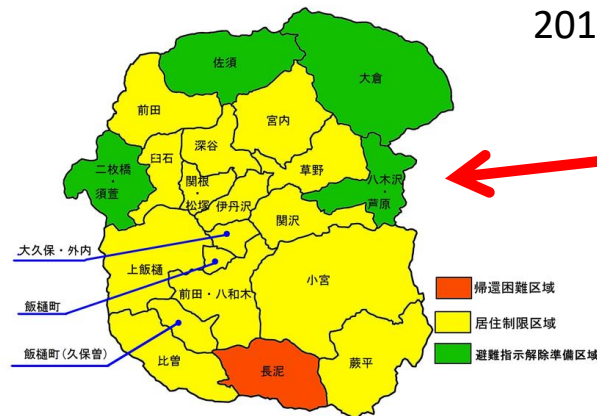
(Internet of Things) - (Internet) = (only Things)



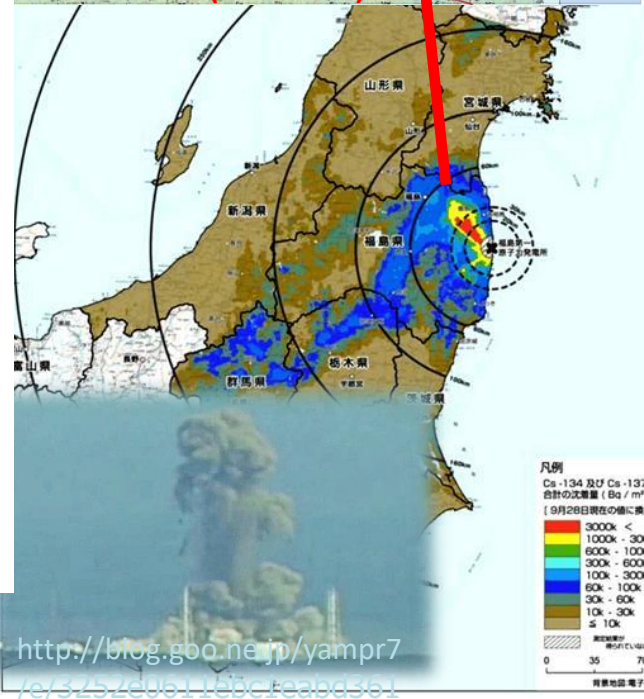
The IoT is only a trash if non-internet

Introduction

- Iitate Village in Fukushima Prefecture
 - 75% covered with mountains and forests
 - well-known as one of the most beautiful villages in Japan
 - **contaminated by radiocesium** released from the nuclear power plant accident in 2011
 - the villagers were forced to be **evacuated for six years (2011-2017)**
 - Some farmers including new farmers have restarted a new agriculture



2015.6-2017.3

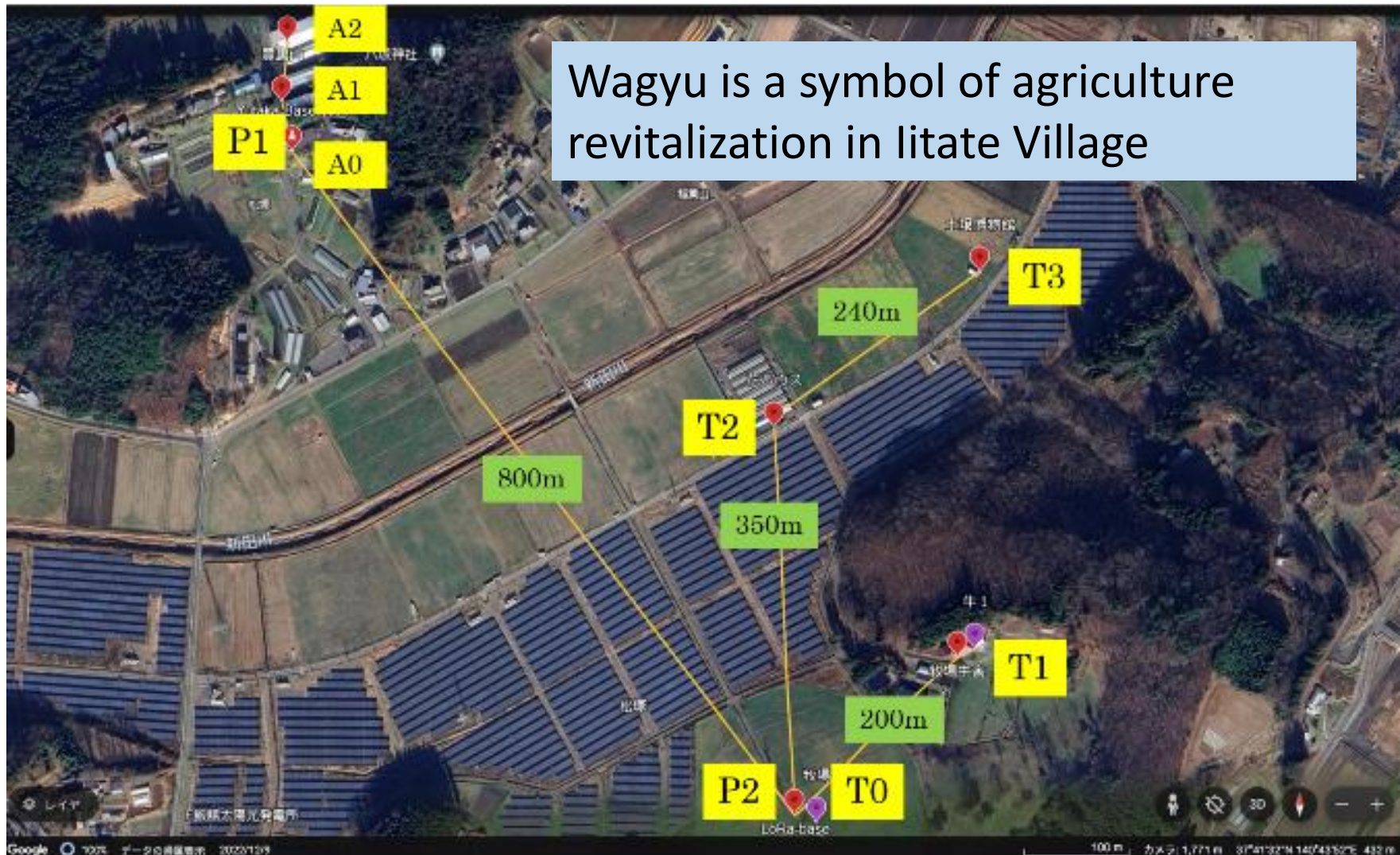


Introduction-2

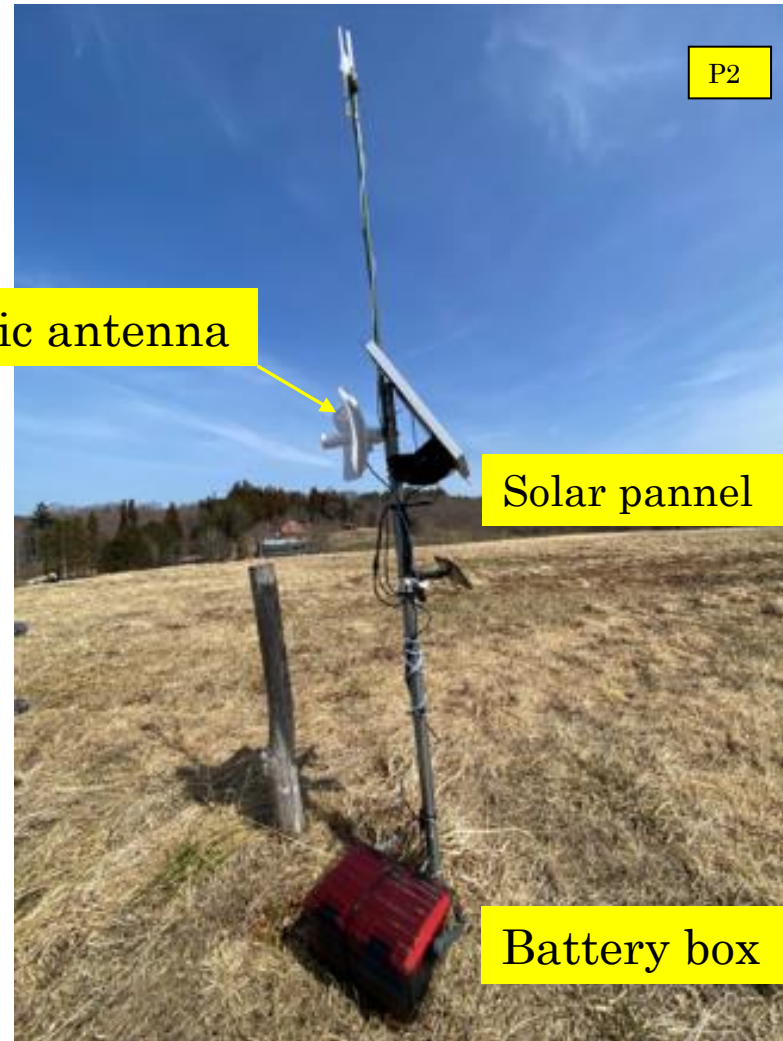


- In order to realize **attractive agricultural and rural lifestyles** such as Half Farmer-Half X and Smart Farming in these areas, **communication infrastructure** is essential.
- However, mountainous forests prevent the development of wide-area communication infrastructure.
- Last year, Mizoguchi et al.¹⁻²⁾ extended home Internet to the outdoors by placing outdoor Wi-Fi repeaters in farmland with good visibility, and conducted animal monitoring experiments with monkeys and other animals to demonstrate that farmers can establish their own Wi-Fi communication infrastructure.
- Therefore, in this study, we further extended the range of Wi-Fi extension and conducted an experiment of a long-distance Wi-Fi mesh net farm to monitor cows on a farm from home.

Method- Layout of the two internet communication networks from home



Method- Long distance communication using parabolic Wi-Fi antennas



Results and Discussion

(1) Confirmation of communication by WiFi camera

The Wi-Fi mesh net farm can be observed with an outdoor Wi-Fi camera (e.g., Reolink Argus ECO/PT, which can be purchased for 10,000 to 20,000 yen including solar panels, Reolink) installed at the site.

- All of these images can be viewed **in real time**. If you put a micro-SD in the camera, it also records 8 seconds of video as standard. The camera also has an infrared (**PIR**) detection function, so by adjusting the sensitivity appropriately, it is possible to capture the appearance of wild boars and monkeys in addition to cows, as we reported at last year's Reconstruction Agriculture Society³⁾



Fig.4 Cows sunbathing outdoors



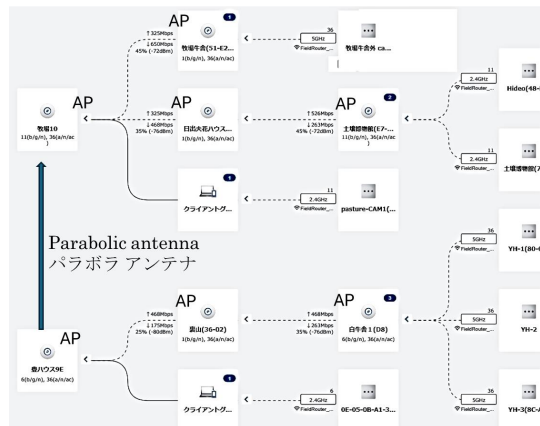
Fig.5 Cows eating feed in A2 barn

Results and Discussion

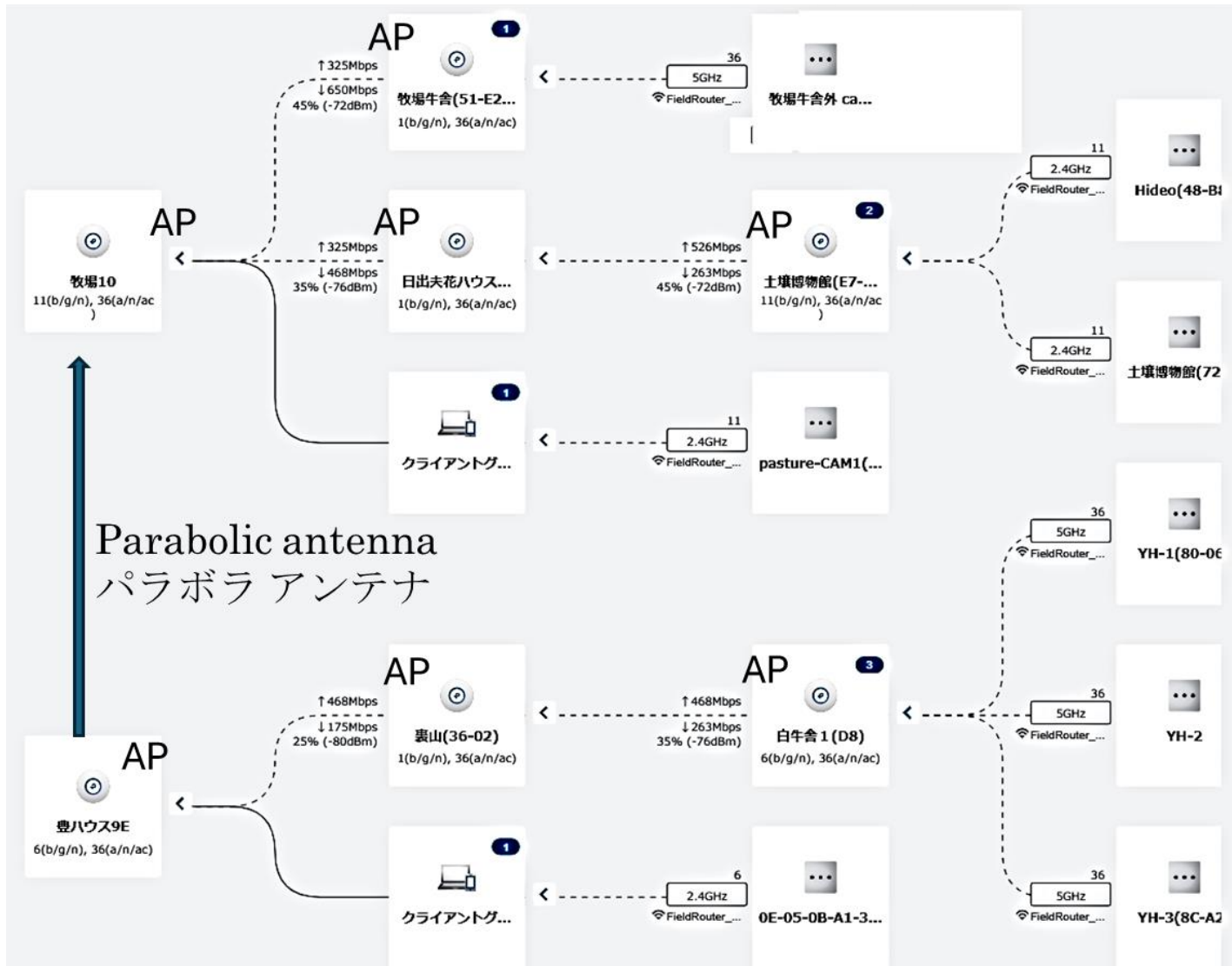
(2) Confirmation of mesh net Wi-Fi communication

The mesh net Wi-Fi communication status can be easily checked in the field using a smartphone app for the Omada Cloud Controller (TP-LINK OC200, TP-Link)

Omada's PC software also displays a topology map as shown in Fig. 1, which is useful to see at a glance which Wi-Fi camera is connected to the Internet along which route.



Topology of the long-range Wi-Fi mesh network farm



Results and Discussion

(3) Tips when installing antennas

- Parabolic antennas are fixed so that they face each other, so communication is stable.
- On the other hand, outdoor AP antennas may change direction due to wind and rain, resulting in reduced communication strength.
- In such cases, it is recommended to fix the two antennas with gummed tape to prevent the antennas from breaking.
- In addition, when AP antennas are attached to poles and propped up against utility poles, care must be taken to ensure that the poles are not in the shadow of the communication.
- In fact, a slight modification of the antenna angle in another area where we installed last year resulted in much better communication.
- Furthermore, if the communication environment for the Wi-Fi camera is poor, simply raising the antenna using an extension cable will improve communication.



Conclusion

- In this study, we conducted a demonstration experiment to extend the home Internet to a farm by combining long-distance communication using a parabolic antenna and an outdoor AP antenna.
- As a result, it was found that the home Internet connection can be extended to the farm if the antenna is properly installed, paying attention to the height and visibility.
- This method could also be applied to a Starlink satellite Internet.
- We look forward to further developments in the future.



References

1. Mizoguchi, M., Itakura Y., and Kobayashi, T. (2023). Prototype of a Wi-Fi-LoRa mesh network relay system in a mid-mountainous area. Proceedings of the Japanese Society of Irrigation, Drainage and Rural Engineering, pp. 529-530 (in Japanese). <https://soil.en.a.u-tokyo.ac.jp/jsidre/search/PDFs/23/8-6.pdf>
2. Kawasumi, T., Zhang, T., Sugino, H., and Mizoguchi, M. (2023). Development of animal monitoring method in mountainous areas using PIR camera. Journal of Resilience Agriculture and Sciences, Vol.3 (2), p.46 (in Japanese). <https://fukkou-nougaku.com/wp-content/uploads/2024/08/JRAS20230731036.pdf>
3. Mizoguchi, M., and Itakura Y. (2024). Field Wi-Fi Extension Experiment in Iitate Village. Journal of Resilience Agriculture and Sciences, Vol.4 (2), pp.8-13 (in Japanese). https://fukkou-nougaku.com/wp-content/uploads/2024/08/c2_JRAS_v4n2_OriginalPaper_Mizoguchi_20240731.pdf

表 1 AP間の距離 (m)と通信強度 (dBm)

キャンプ場経路	K0	<100>	K1	<205>	K2	<42>	K3
信号強度(dBm)		-60		-76		-68	
管理事務所経路					K2	<70>	K2-1
信号強度(dBm)						-75	
公園広場経路	K0	<105>	P1	<290>	P2		
信号強度(dBm)		-60		-66			

<数字>はAP間の距離 (m) 信号強度(dBm)は天候によって±2程度変動する



表2 主な機器・機材と概算費用

	種別	機種	数量	単価(参考)	合計
1	無線アクセスポイント (屋外用)	EAP225-Outdoor	7	¥22,300	¥156,100
2	コントローラー	OC200	1	¥17,980	¥17,980
3	WiFi無線LANルーター	WSR-1166DHPL2	1	¥3,980	¥3,980
4	防犯カメラ	Argus ECO+SP	2	¥9,000	¥18,000
5	防犯カメラ	E1 Outdoor	3	¥13,000	¥39,000
6	LANケーブル(20m)	CAT6A	2	¥1,710	¥3,420
7	LANケーブル(10m)	CAT6A	2	¥1,370	¥2,740
8	単管パイプ等の部材	1.5m	4	¥900	¥3,600
	合計				¥244,820
	注：記載した機器や部材は参考価格				



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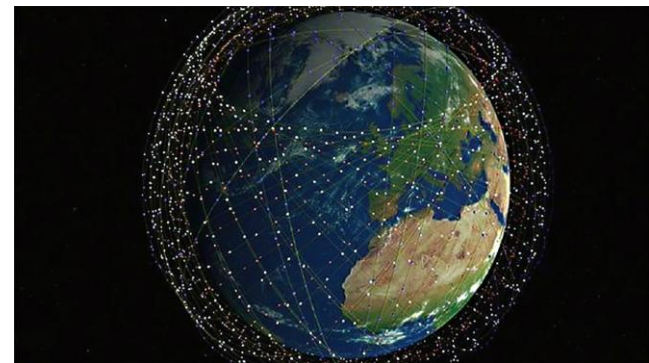


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衛星インターネットの利用

- Starlink衛星インターネット
 - スペースX社の衛星ネットワークによるインターネットサービス
 - 山奥でも空が見えれば利用可能
- Starlink + 中継器（AP） + 電源BOXのセット
 - 同様にWiFiを拡張できる



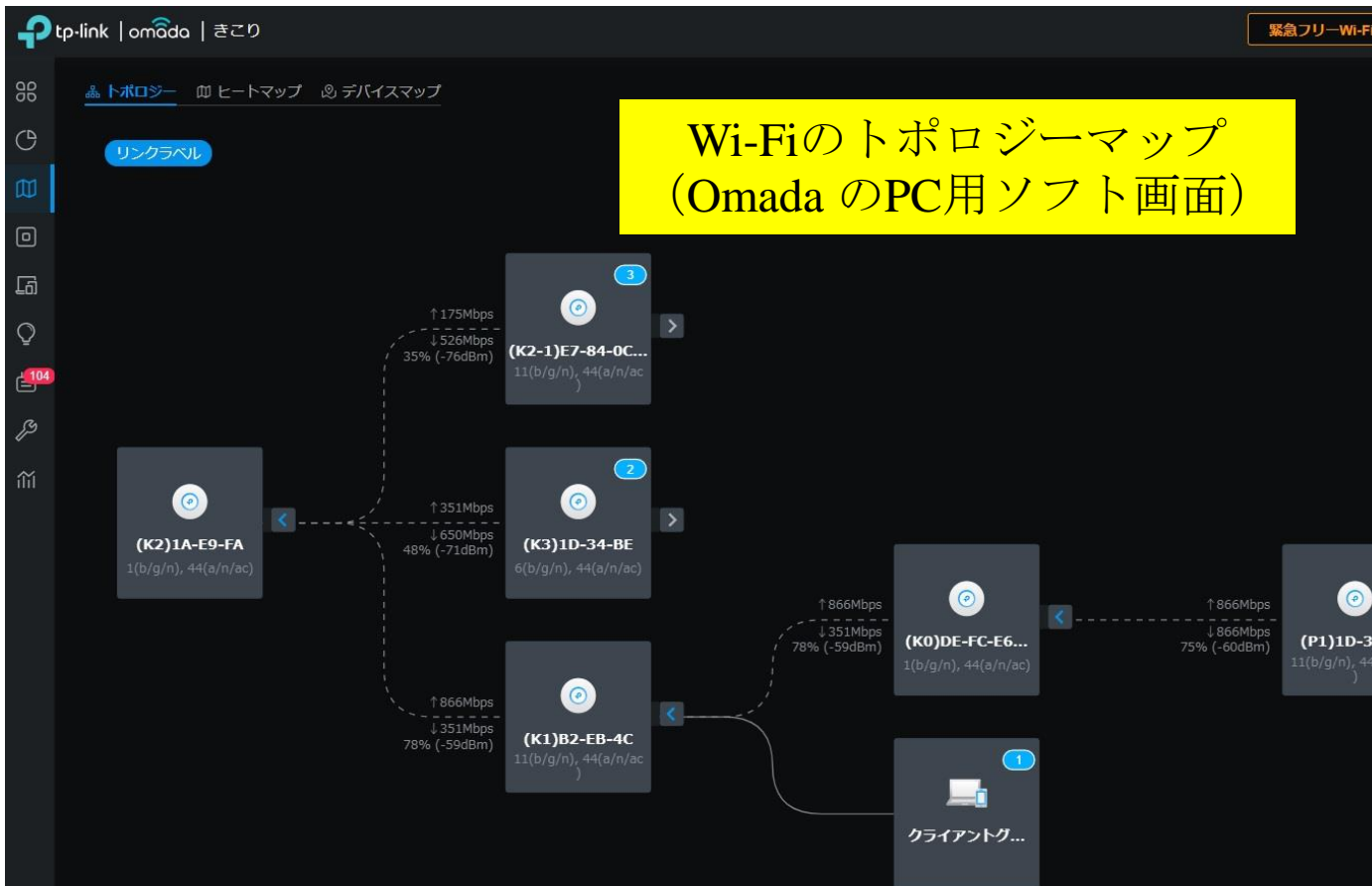
<https://xtech.nikkei.com/atcl/nxt/column/18/00001/08528/>

<https://k-tai.watch.impress.co.jp/docs/news/1610259.html>

結果と考察

(2)メッシュネットワークWiFi通信の確認

(K0)DE-FC-E6親	EAP225-Outdoor	接続済み
192.168.1.18		
(K1)B2-EB-4C	EAP225-Outdoor	接続済み
192.168.1.22		
(K2)1A-E9-FA	EAP225-Outdoor	接続済み
192.168.1.23		
(K2-1)E7-84-0C(管...	EAP225-Outdoor	接続済み
192.168.1.36		
(K3)1D-34-BE	EAP225-Outdoor	接続済み
192.168.1.25		
(P1)1D-36-2C	EAP225-Outdoor	接続済み
192.168.1.70		
(P2)EC-5E-6C	EAP225-Outdoor	接続済み
192.168.1.69		



Method

- Mr. Y, the owner of the farm, has an Internet connection at his house located on a hill in the Matsuzuka district of Iitate Village
- An Internet base station (P1/A0) was set up in the garden from the router of this line. From this base station, two communication networks were deployed. (Fig.1, Fig.2)