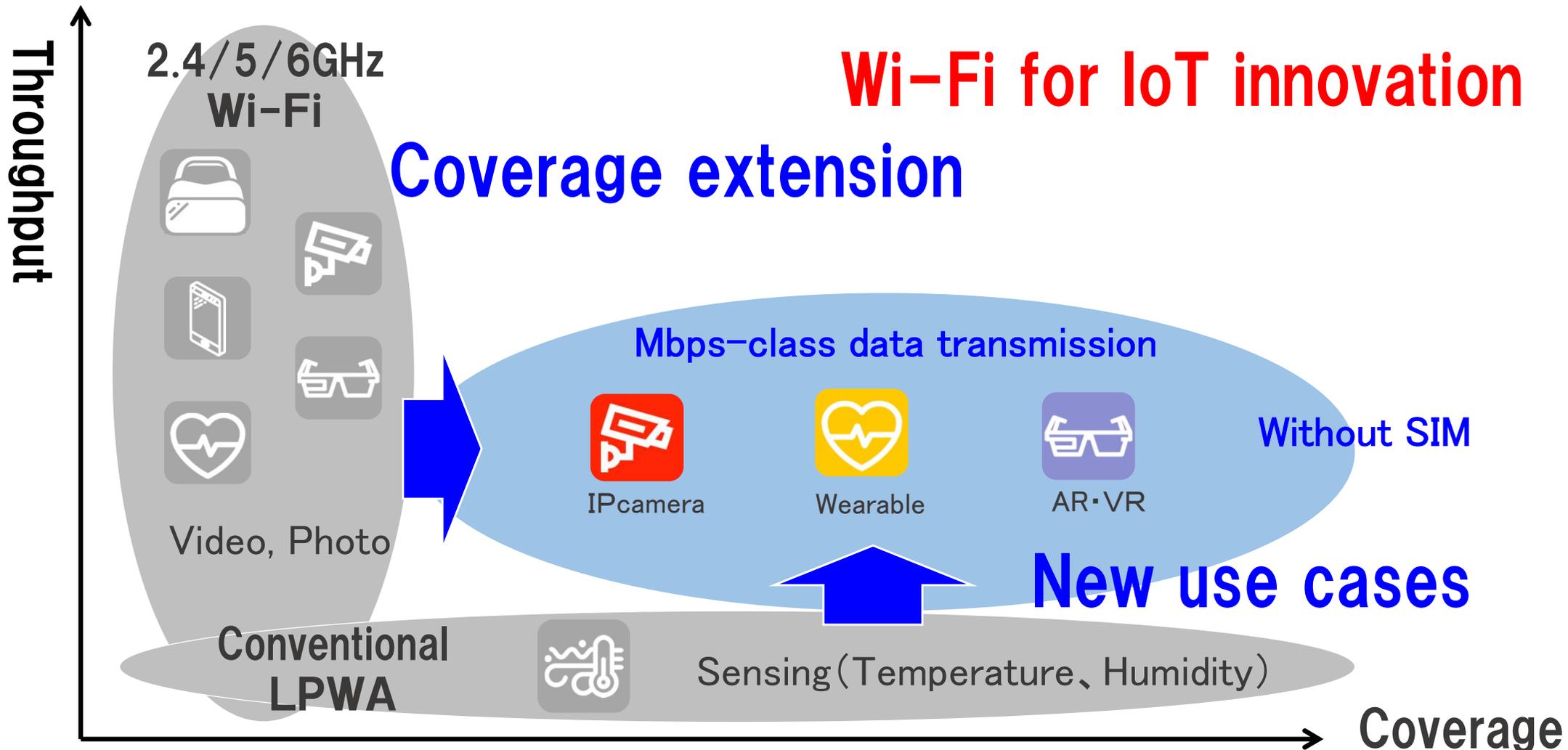


802.11ah future trends in Japan : New frequency development in the 850MHz band and its potential

June 6th, 2024
802.11ah promotion council
Yasushi Takatori

IoT innovation with 802.11ah

802.11ah / Wi-Fi HaLow is available in Japan since 2022



Requirements for IoT wireless access

- Coverage / reliability in indoor/outdoor environment:
 - NB-IoT > LPWA > 802.11ah > Local 5G > Wi-Fi
- High throughput for video transmission:
 - Wi-Fi ≐ Local 5G > 802.11ah > NB-IoT > LPWA
- Easy deployment:
 - Wi-Fi ≐ 802.11ah >> LPWA ≐ NB-IoT >> Local 5G
- Lower cost:
 - 802.11ah ≐ Wi-Fi < NB-IoT < LPWA << Local 5G
- Robust security
 - NB-IoT ≐ Local 5G > 802.11ah ≐ Wi-Fi >> LPWA
- Lower power consumption
 - NB-IoT ≐ LPWA ≐ 802.11ah << Wi-Fi << Local 5G
- Lower latency
 - Local 5G ≐ Wi-Fi < 802.11ah << NB-IoT < LPWA
- Massive connectivity
 - NB-IoT ≐ LPWA ≐ 802.11ah > Wi-Fi ≐ Local 5G

- Source: Wi-Fi HaLow™: Wi-Fi® for IoT applications

<https://www.wi-fi.org/file/wi-fi-certified-halow-wi-fi-for-iot-applications-2021>

- LPWA: Wi-SUN, LoRa/SIGFOX/ZETA, ELTRES

Comparison with other wireless systems for IoT

802.11ah enables high data transmission keeping the multi-km range compared to other systems.

System Attributes	802.11ah	Conventional LPWA			Cellular
		LoRaWAN	Wi-SUN	SIGFOX	NB-IoT
Frequency	Sub-1 GHz	Sub-1 GHz	Sub-1 GHz	Sub-1 GHz	Sub-1 GHz
Range	>2.5 km*	<10 km	<1 km	<40 km	<10 km
Data rate (bps)	150K- 20M**	300-27k	6.25k- 800 k	100 or 600	20k- 127k
license-exempt bands	✓	✓	✓	✓	-
Battery life ***	Years	Years	Years	Years	Years

This table is created based on the white paper published by Wi-Fi Alliance.

***>2.5km: 2Mbps@2.5km is confirmed by the measurement conducted by AHPC**

****20M: Maximum data rate with 4 MHz BW and 1 spatial stream specified in the standard**

***** Battery life: Expected battery life for wireless sensors**

Features of 802.11ah

Sub-1 GHz

- Range of >1km
- Robust wireless link

Easy installation

- Star / tree configuration
- Accommodates 1024 devices
- Range extension by relay

Low power consumption

- Sleep modes
- Power saving mechanism

Sub-1 GHz (802.11ah)

Flexible band width

- 1/2/4 MHz bands
- From 150 kbps to multi-Mbps

Wi-Fi brand IoT

- Internationally popular IP-based standard
- WPA3 provides high security

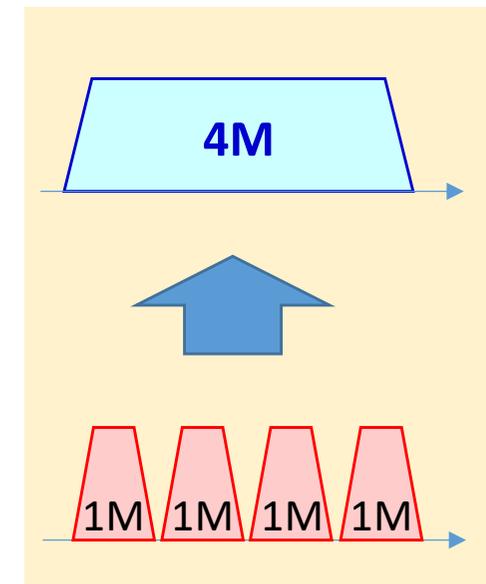


1/2/4MHz mode is available

4.5 times throughput is expected with 4MHz mode compared to 1MHz mode.



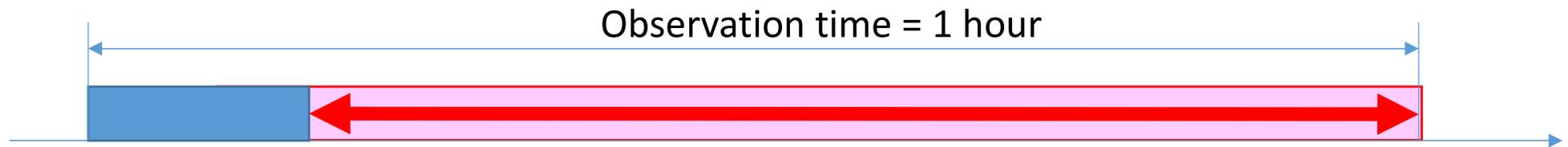
MCS index	Modulation type	Coding rate	PHY Data rate (Mbit/s)		
			1 MHz channels	2 MHz channels	4 MHz channels
7	64-QAM	5/6	3.34	7.22	15.0
6	64-QAM	3/4	3.0	6.5	13.5
5	64-QAM	2/3	2.67	5.78	12.0
4	16-QAM	3/4	2.0	4.33	9.0
3	16-QAM	1/2	1.33	2.89	6.0
2	QPSK	3/4	1.0	2.17	4.5
1	QPSK	1/2	0.67	1.44	3.0
0	BPSK	1/2	0.33	0.72	1.5



Duty-cycle restriction in 920MHz

It is mandatory to transmit so that each radio station's total transmission time per hour is 360 seconds or less (10 % or less duty cycle). Setting the **observation time to 1 hour** is adequate when performing high-speed transmission only once per hour. Setting **the observation time short (1 second or less)** is effective for continuous communication such as video/audio streaming.

■ When performing high-speed transmission once an hour



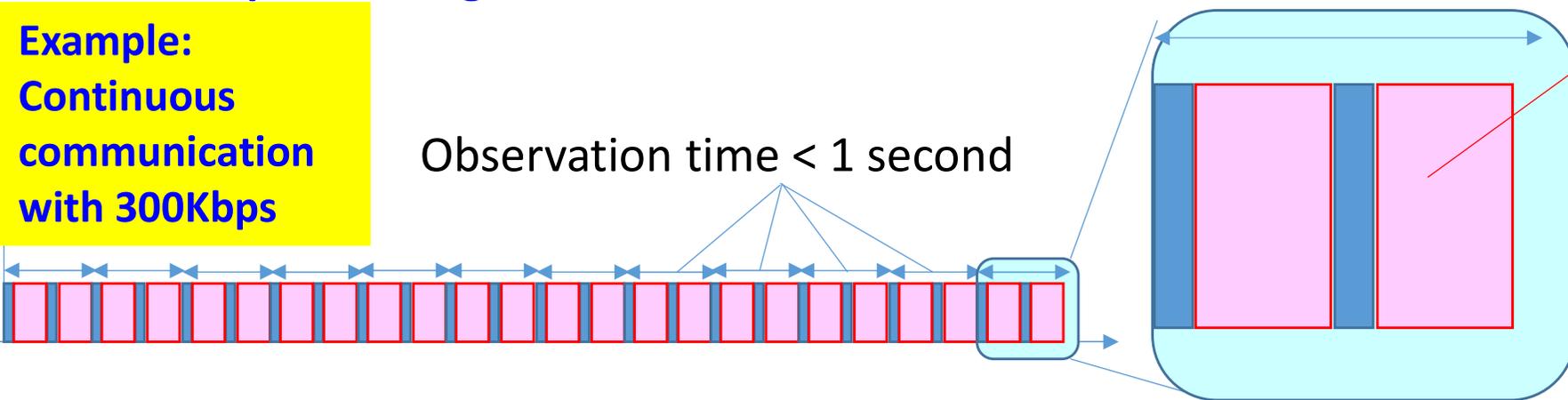
Example: 3Mbps data transmission for 10 minutes Must NOT transmit data for remaining 50 minutes

■ When performing continuous communication

**Example:
Continuous
communication
with 300Kbps**

Observation time < 1 second

No-transmission

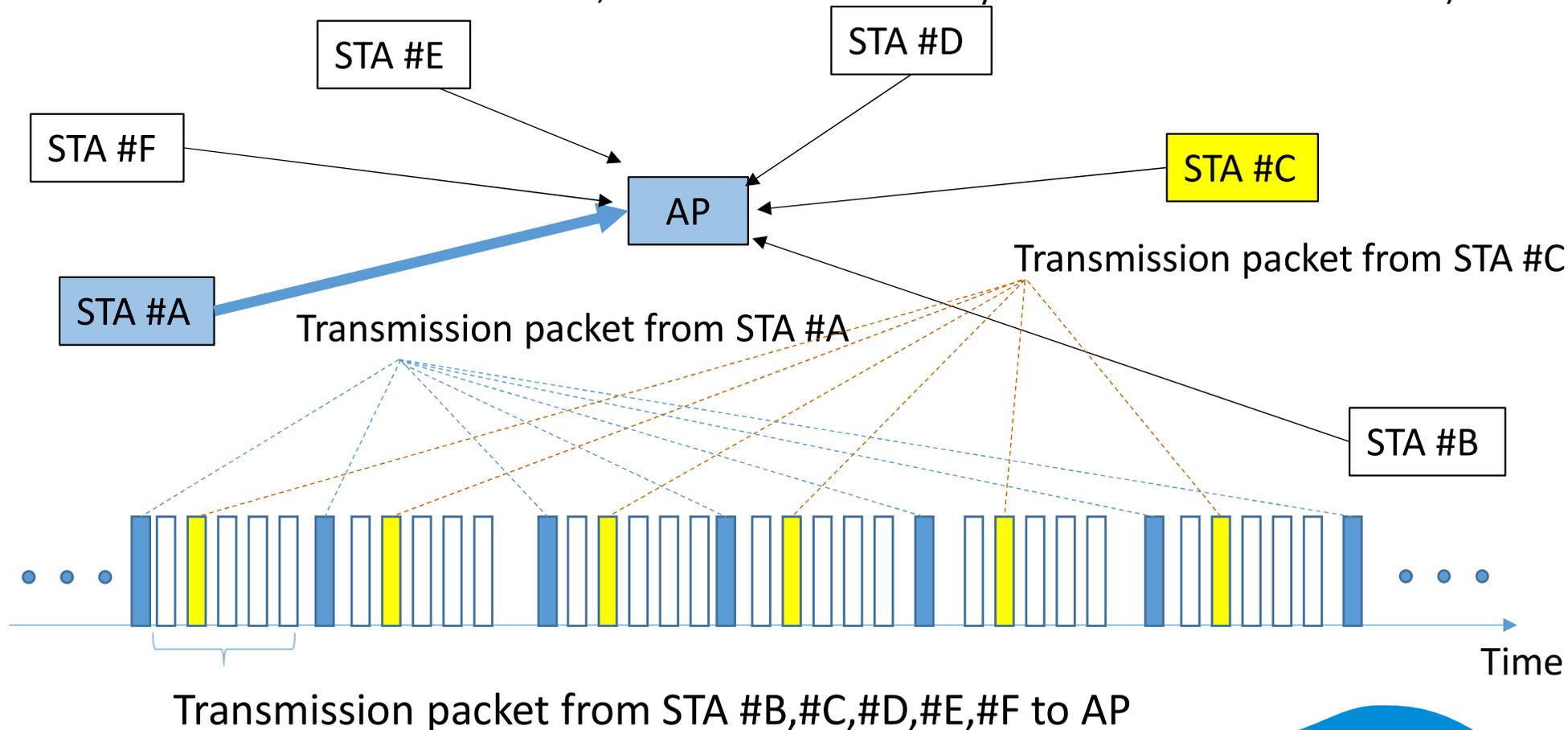


Duty-cycle restriction in multi-link scenarios

Wideband transmission using 1/2/4MHz bands makes transmitting video, such as moving images, possible.

Uninterrupted transmission is possible while maintaining the duty ratio by sending data in short segments. Duty restriction is applied to each STA.

(i.e. if there are five STAs associated to an AP, the AP can receive totally 50 % of time from all the STA.)



NEXT STEP

More and more varieties of devices and applications are expected in the next step.

Current 11ah market

Agriculture & Livestock



Local safety



School



Disaster prevention



Extending the market

NEW market creation

Next Step

Factories, Logistics



- Environmental monitoring
- Production management
- Use of dedicated terminals
- Digitization of analogue meters

Regional revitalization



- Environmental monitoring
- Safety management

Office



- Office environmental management and monitoring
- Entry/exit management / Intrusion detection

With Matter Home



- Vital management of the elderly
- Home security: Door lock management, parking monitoring

(From the article) Wi-Fi HaLow for Smart Home

NTT east's initiatives for Smart Home with home IoT/Matter

URL <https://japan.cnet.com/article/35216010/>

March 14th, 2024

* The article is in Japanese.

Why NTT East is enthusiastic about smart homes becoming "fully popular" in 2024 -- **new Wi-Fi standard makes it easier to connect**

"We believe that by promoting Wi-Fi HaLow, the instability of communication will be resolved."



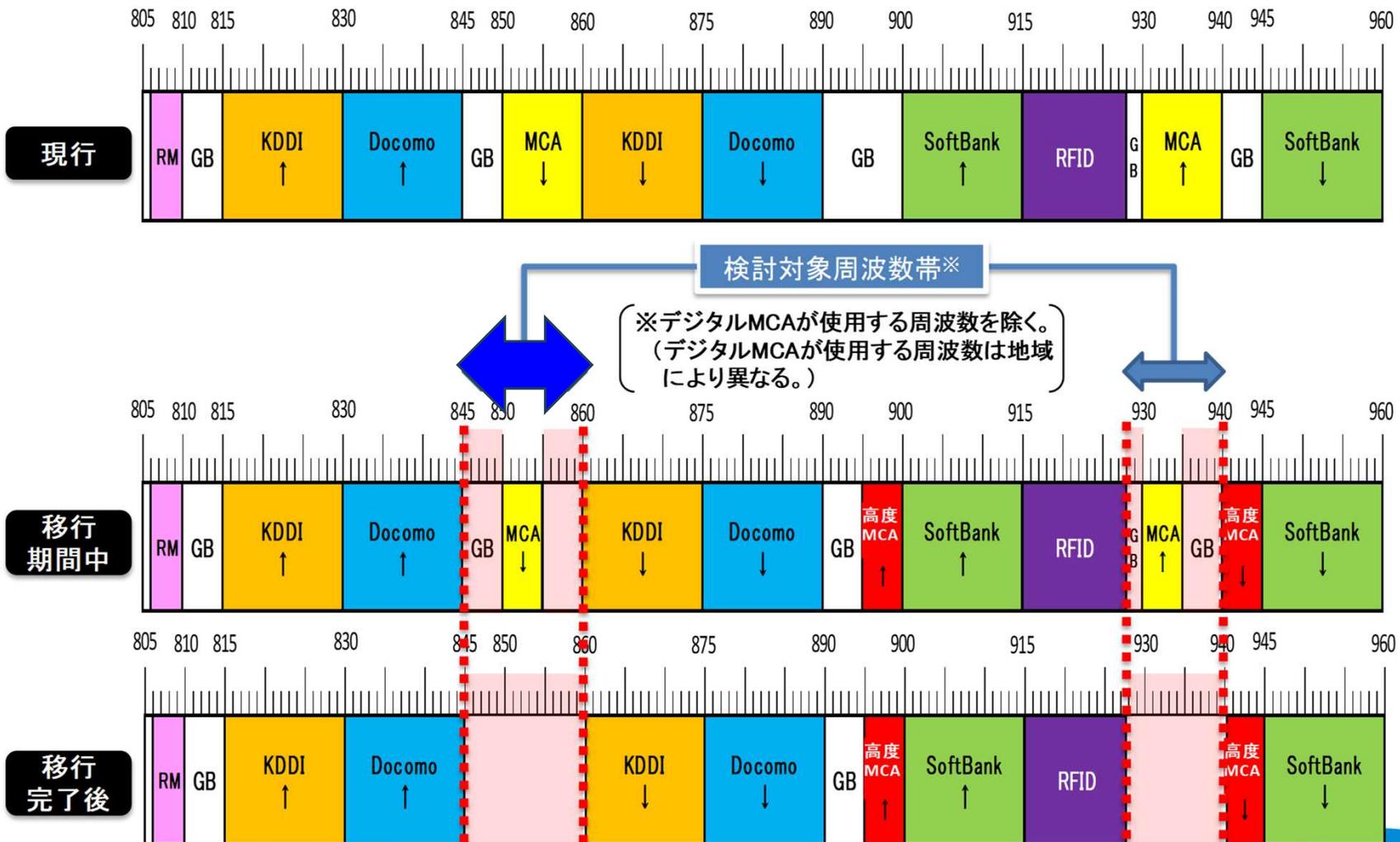
PHOTO from <https://japan.cnet.com/article/35216010/>

Matter: <https://csa-iot.org/>

New frequency development in the **850MHz band** and its potential

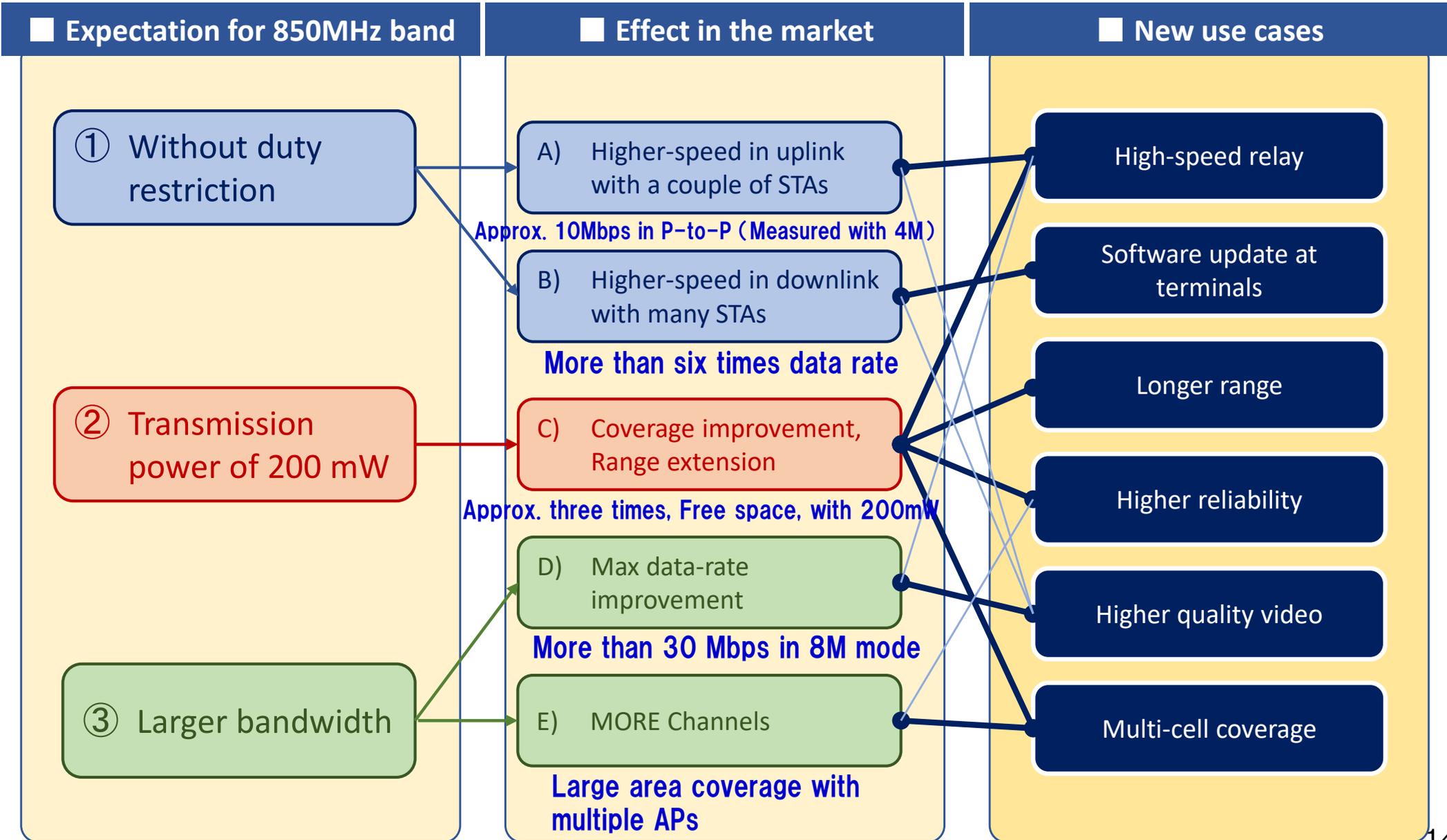
Possible new frequency bands for 802.11ah

Digital MCA system operating in both 845-860 MHz band and 930-930 MHz band will move to different frequency bands. Japanese ministry (MIC: Ministry of Internal Affairs and Communications) has launched an official working group to discuss the **frequency allocation of 845-860MHz** for new wireless systems, **802.11ah** and **Metropolitan Beacon System (MBS)** in April 2024.



Expectation for 850 MHz band to expand the IoT market

Expected effect in 850MHz band and new use cases



Toward further fruitful expansion

New frequency allocation at 850MHz band enhances the key features in all use-cases.

- Agriculture & Livestock**
- Local safety**
- School**
- Disaster prevention**

Extending the market

NEW market creation

Next Step

Further enhancement

■ Factories, Logistics ■

- Environmental monitoring
- Production management
- Use of dedicated terminals
- Digitization of analogue meters

- Higher reliability
- Higher quality video

Software update at terminals

■ Regional revitalization ■

- Environmental monitoring
- Safety management

- High-speed relay
- Longer range

Multi-cell coverage

Software update at terminals

■ Office ■

- Office environmental management and monitoring
- Entry/exit management / Intrusion detection

- Higher reliability
- Higher quality video

Multi-cell coverage

Software update at terminals

With Matter ■ Home ■

- Vital management of the elderly
- Home security: Door lock management, parking monitoring

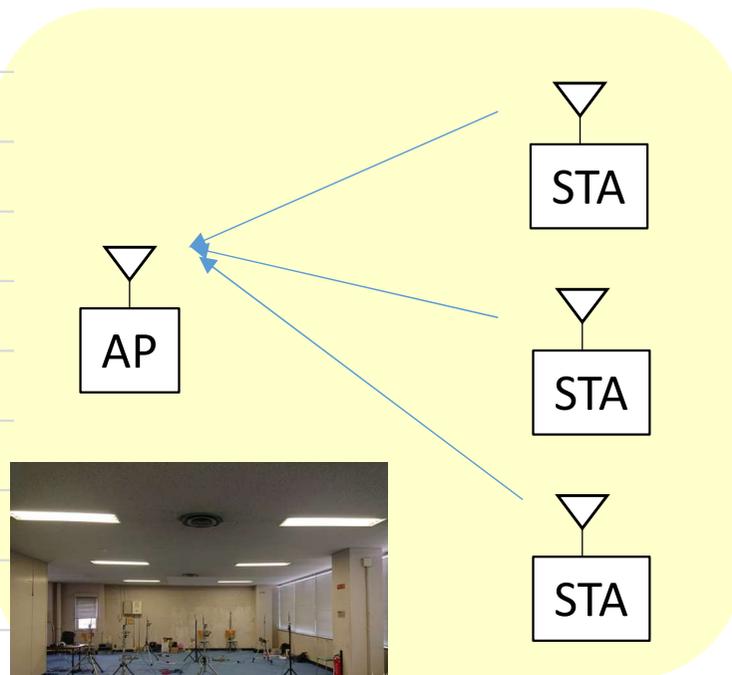
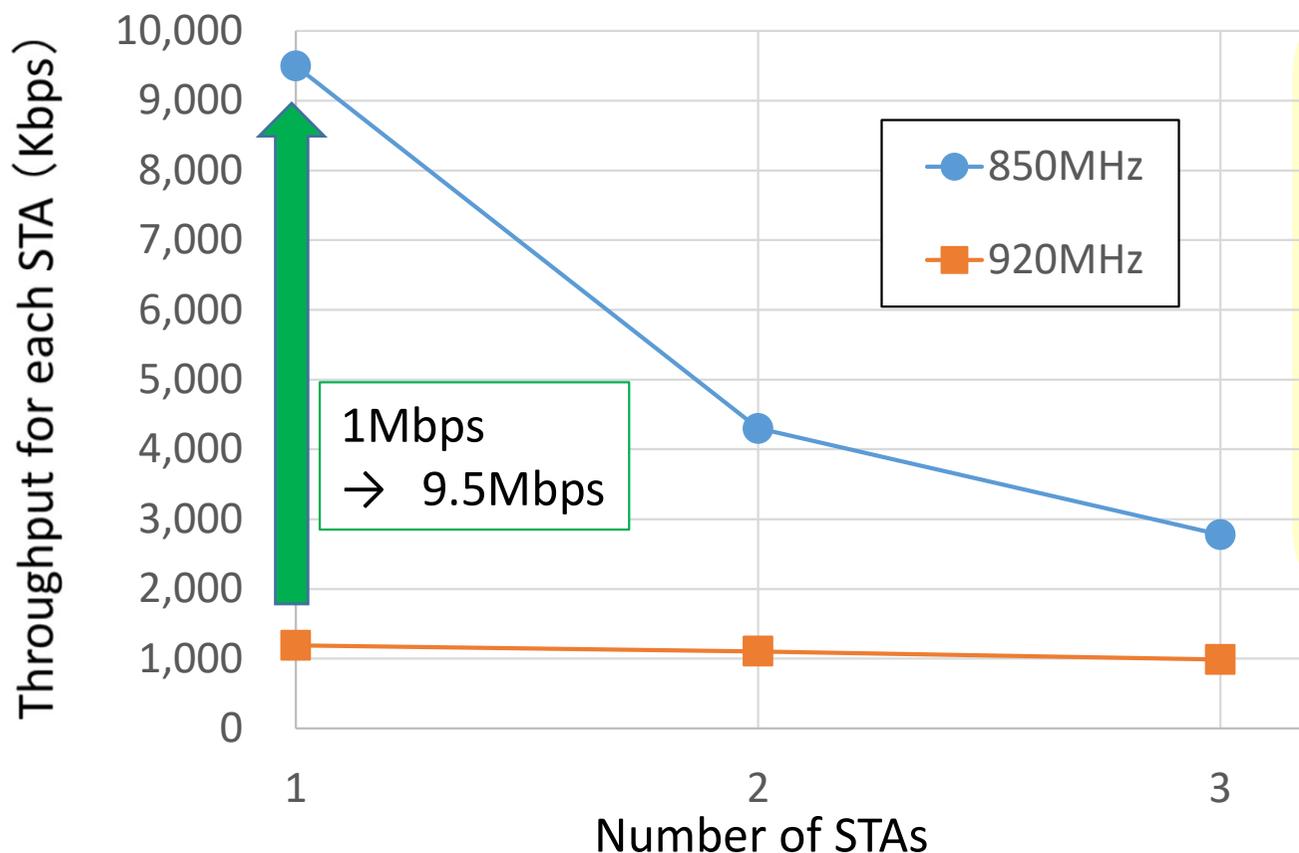
- Higher reliability
- Higher quality video

Software update at terminals

10 Mbps class transmission is proved in uplink P-to-P by the trial.

802.11ah @850MHz : 4MHz mode, **without duty-cycle restriction**, with A-MPDU

802.11ah @920MHz : 4MHz mode, with duty-cycle restriction, without A-MPDU

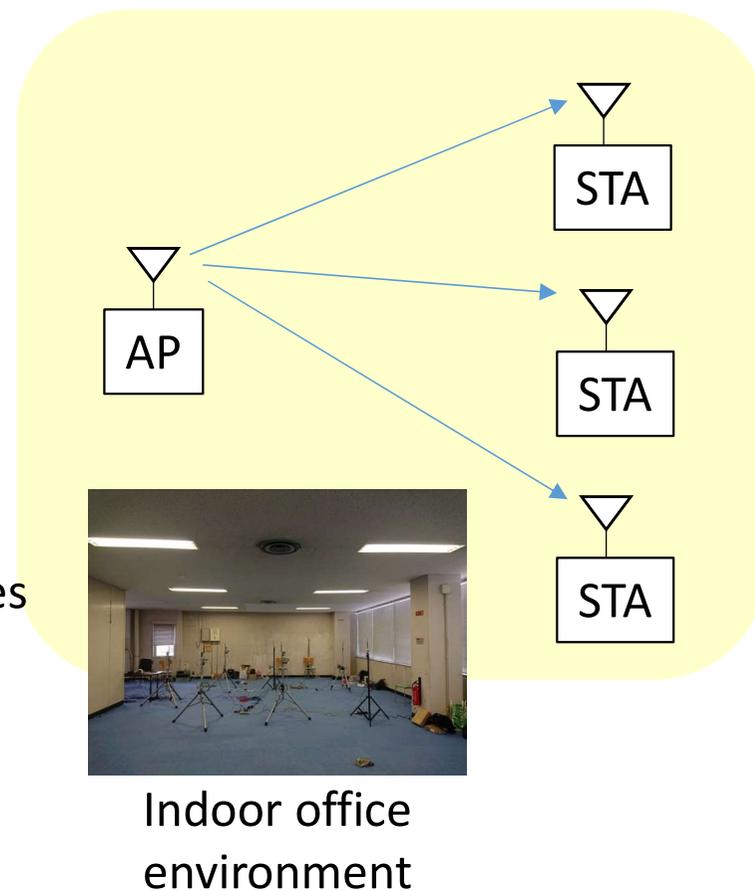
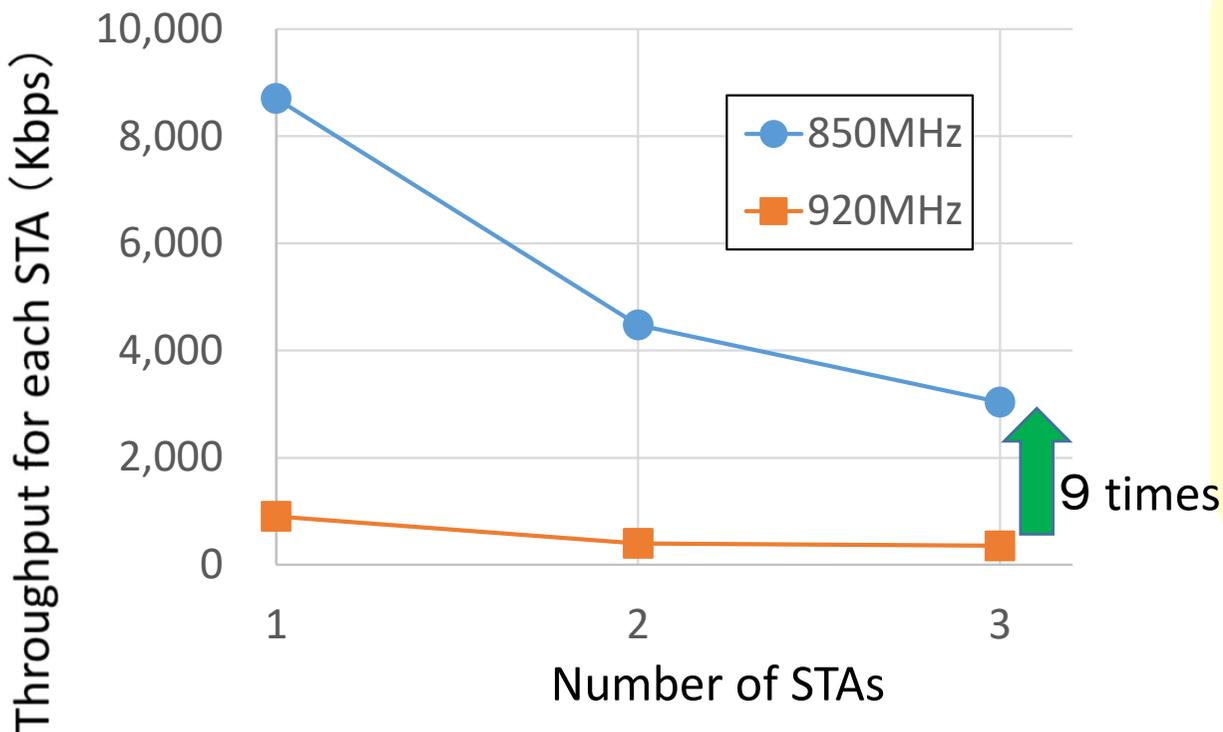


Indoor office environment

About **9 times throughput** is proved in down link P-to-MP by the trial.

802.11ah @850MHz : 4MHz mode, without duty-cycle restriction, with A-MPDU

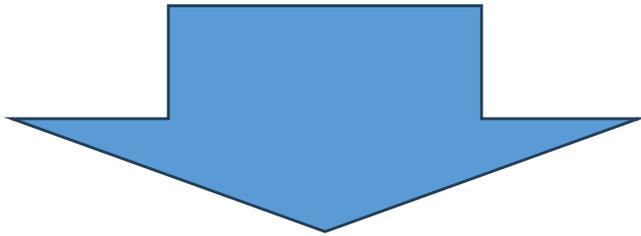
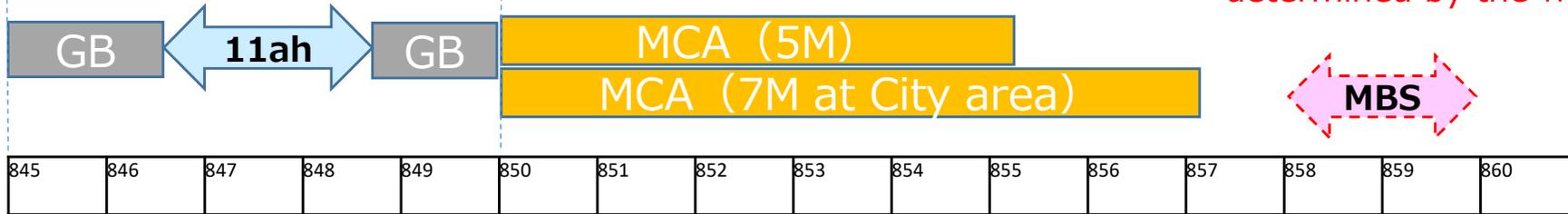
802.11ah @920MHz : 4MHz mode, with duty-cycle restriction, without A-MPDU



Expected frequency allocation at 850MHz

■ During the transition period:

※ Actual GB width will be determined by the working group.

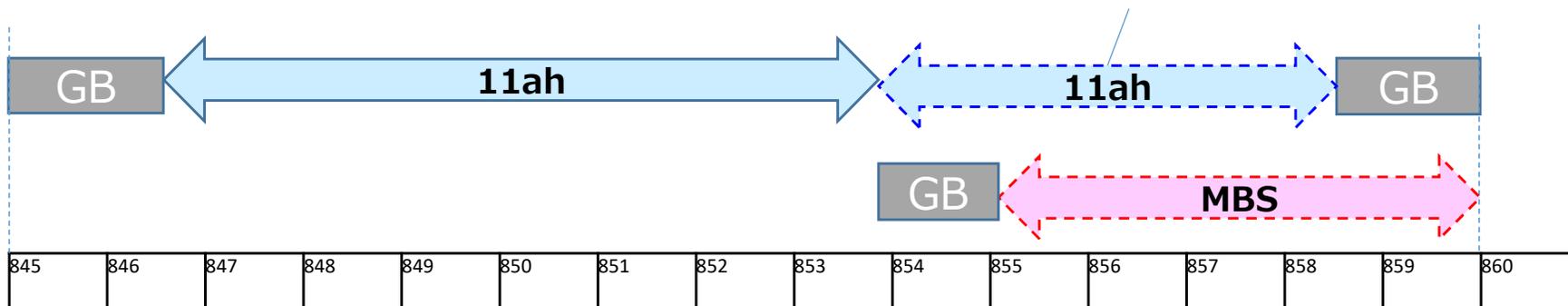


Steep BPF suppressing interference at the adjacent frequency bands will reduce GB and thus enable broader frequency band allocation.

■ After the transition, June 2029~

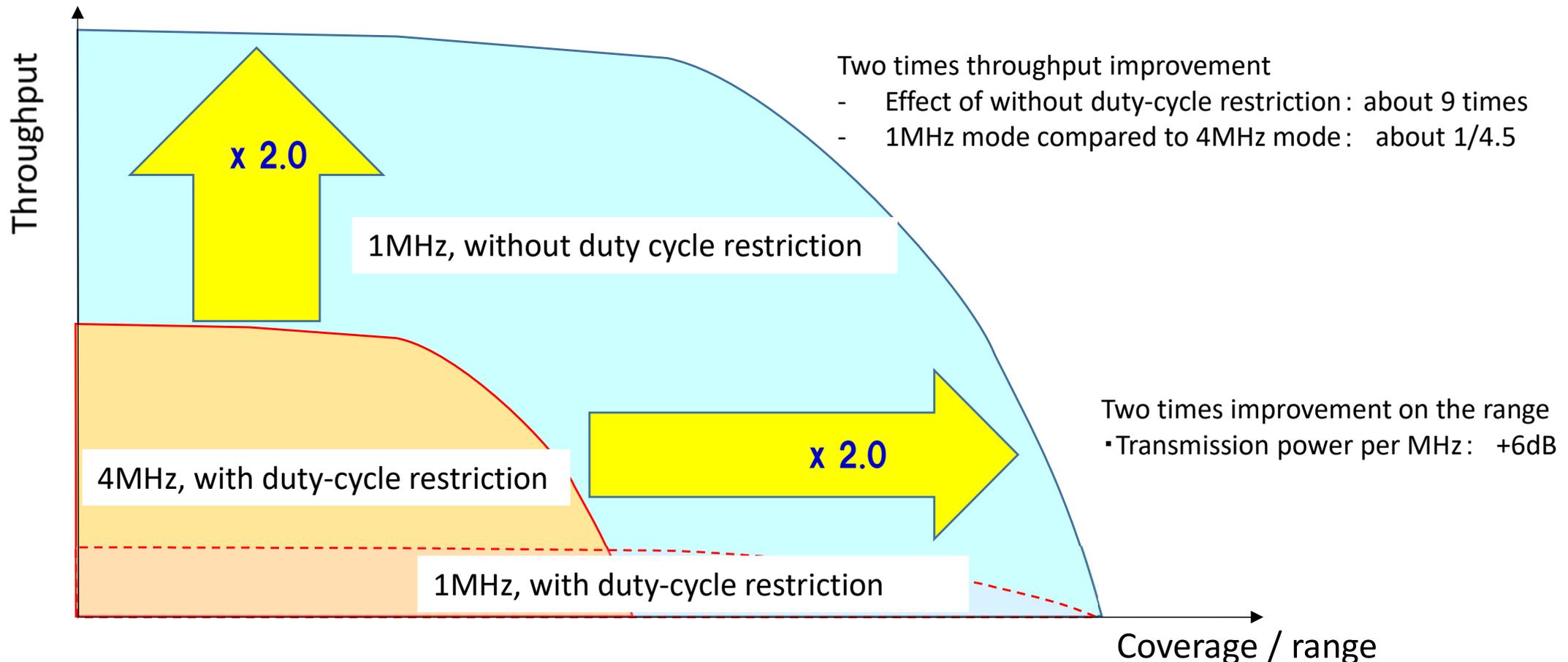
※ Actual GB width will be determined by the working group.

How to coexist with MBS is one of the working items at the working group.



Expected improvement by the “duty-cycle restriction free”

Even in the case of 1MHz band transmission without duty-cycle restrictions, it enables to double both maximum throughput and communication range compared to the current 4MHz mode at the 920MHz band with 10 % of duty restriction.



Effect of without duty-cycle restriction in P-to-P with 1MHz mode

Summary

- 802.11ah has been available in Japan since 2022. However, due to **the limited variations of devices**, the current 11ah market is limited to agriculture and livestock, local safety, school, and disaster prevention.
- The next step is to extend the current market. Moreover, creating a new market, such as **office/home IoT**, is essential. Support from Taiwan companies is helpful in realizing this step.
- A new frequency allocation of 850MHz is under discussion, which will enhance the expansion of the market.
- In addition to the available frequency expansion, we expect duty-cycle restriction-free operation in the new frequency band. This will improve the throughput and coverage area even in 1MHz mode in the transition period.
- **Steep BPF and the coexistence with MBS** enable broader frequency band allocation for 802.11ah in Japan.

Wi-Fi HaLow: The Future of Long-Range Wireless is Here

Thursday, 20 June 2024
7:00 PM - 8:00 PM EDT

LIVESTREAM

SPEAKERS



Zac Freeman
Vice President of Marketing and Sales, Newracom



David Halasz
Director of Standards, Morse Micro
1st Vice Chair, IEEE 802 LMSC



Yasushi Takatori
Senior Distinguished Researcher, NTT
Access Network Service Systems
Laboratories

<https://engagestandards.ieee.org/HaLow-Livestream.html>