Effect of SDMA in 802.11ac

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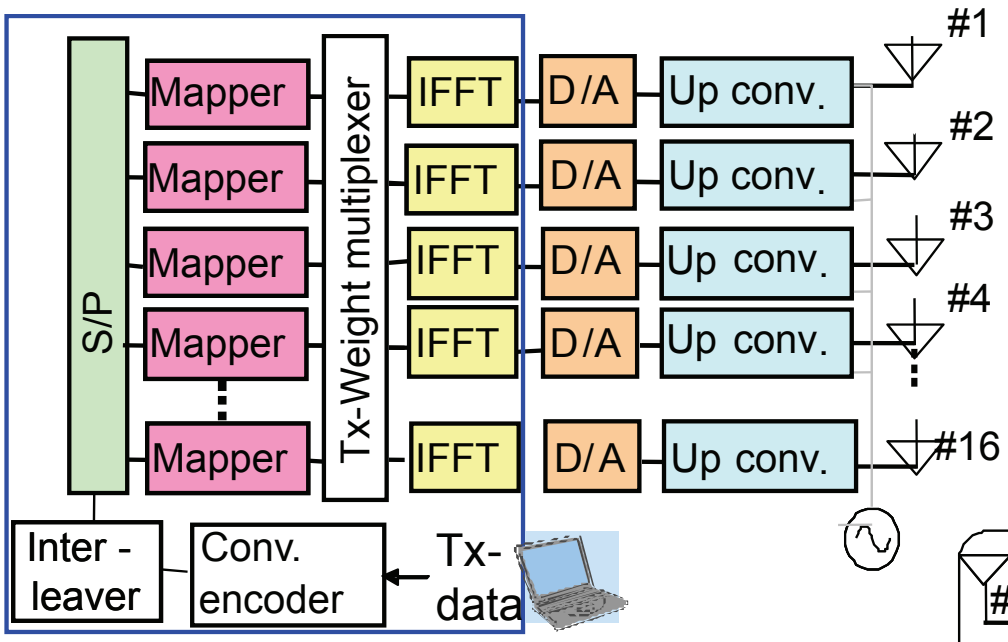
Contents

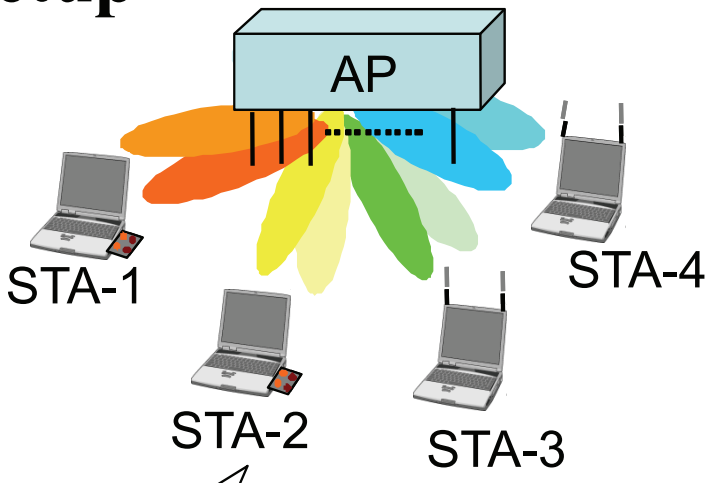
Introduction

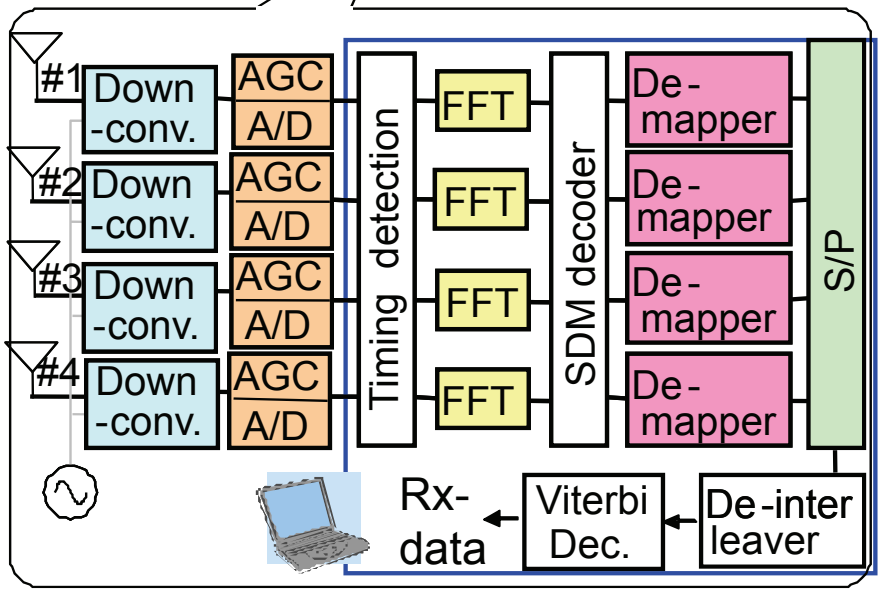
- **In PAR of TGac, more than 1 Gbps throughput must be achieved with multiple STAs.**
- **MIMO-SDMA can be a key technology to reach this very high throughput.**
- **The feasibility of MIMO-SDMA is evaluated in an actual indoor office environment, which can be a typical scenario in 802.11ac.**

Contents

Measurement Setup

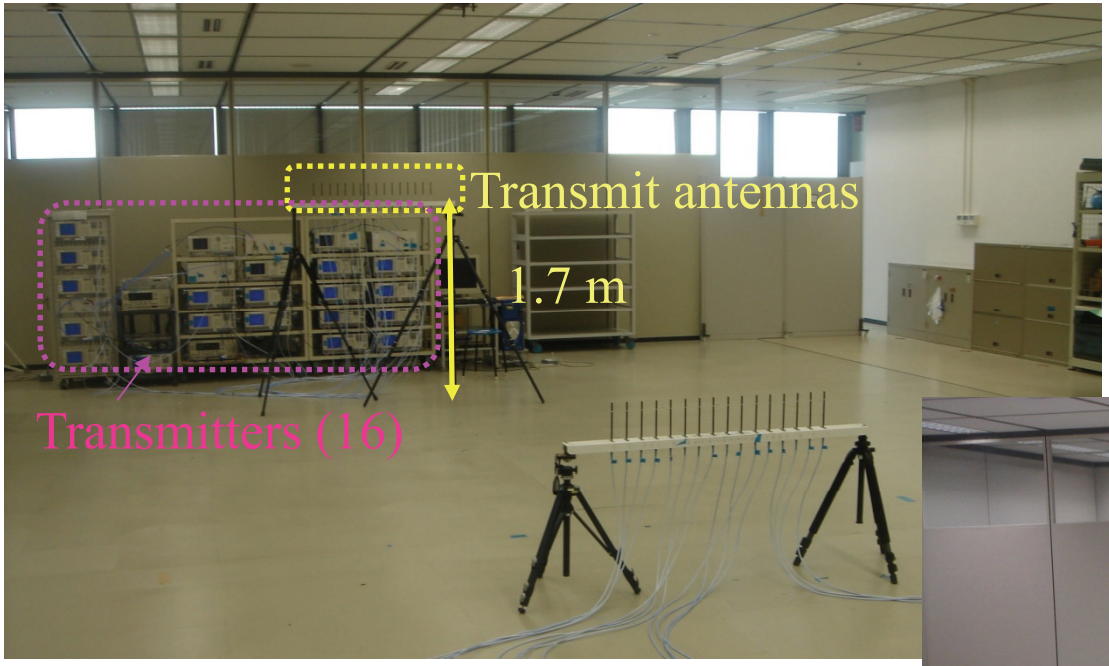






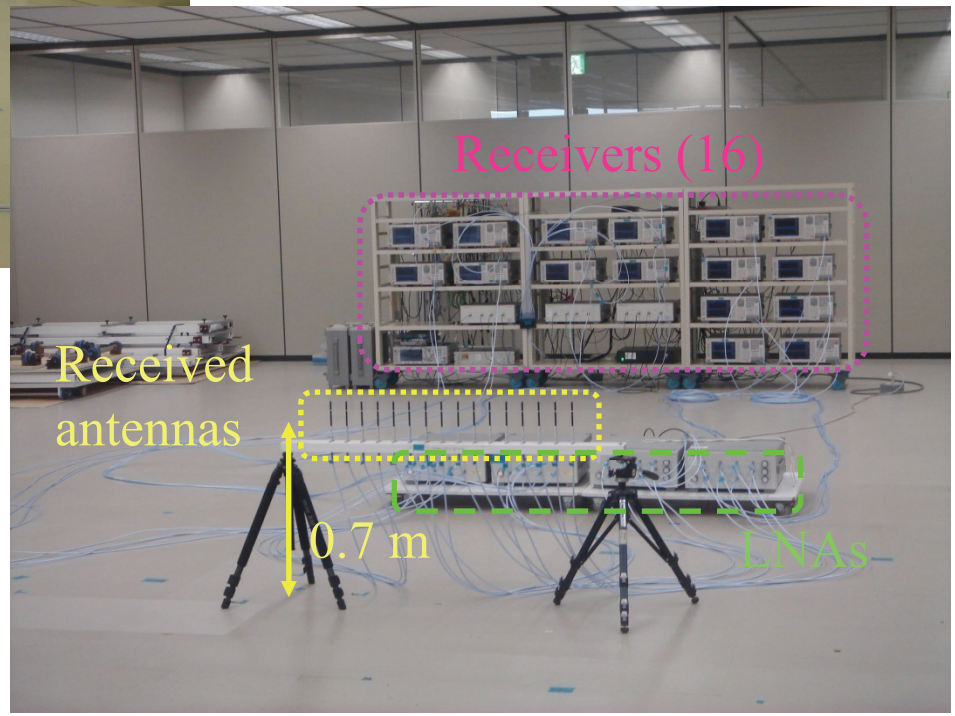
- 16x16 MIMO channel measurements and data transmission at 5GHz with 20MHz BW were conducted at a typical office room in NTT lab.
- Downlink performances were evaluated for up to 8 STAs in static and time variant channels.

Developed Measurement System



Tx site

Rx site



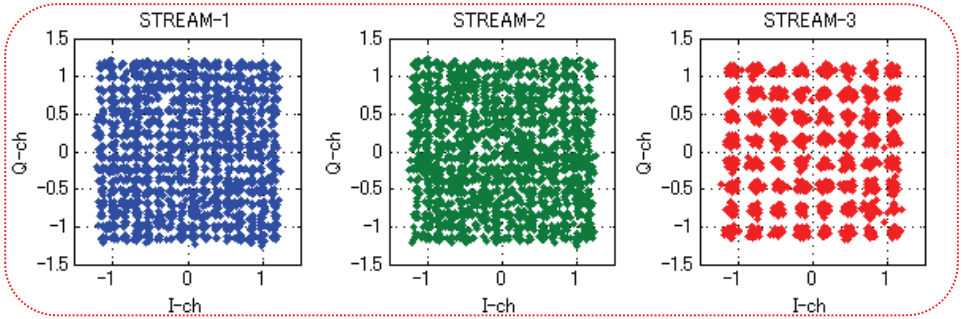
Transmission Parameters

Signal format based on IEEE802.11n is used.

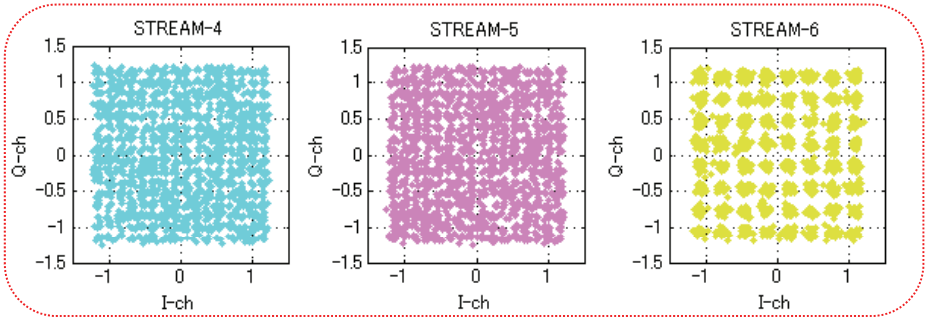
Number of antennas (Tx)	16 (Element spacing: 1λ)
Number of antennas (Rx)	2, 3, 4 (Element spacing: 0.5λ)
Transmit power	Max. 6 dBm (Total)
Packet length	100 coded OFDM signal
Number of subcarriers	48 (Pilot 4)
Pilot signal	6, 20, 34, 48
Bit error	Less than 10^{-7}
Bandwidth	20 MHz
Sampling rate	40 MHz
Modulation scheme	QPSK, 16QAM, 64QAM, 256QAM, and 1024QAM
Coding rate	1/2, 2/3, 3/4, 5/6, and 7/8

Achieved over 42.8 bits/s/Hz (@SNR=30 dB)

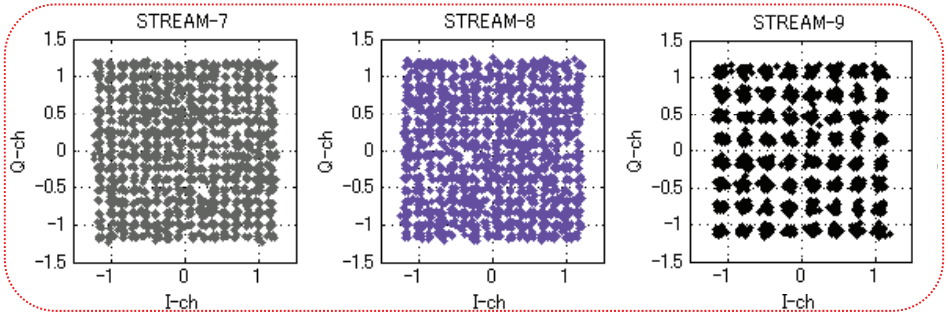
STA-1
(9.8 bit/s/Hz (196Mbps), R=5/6)



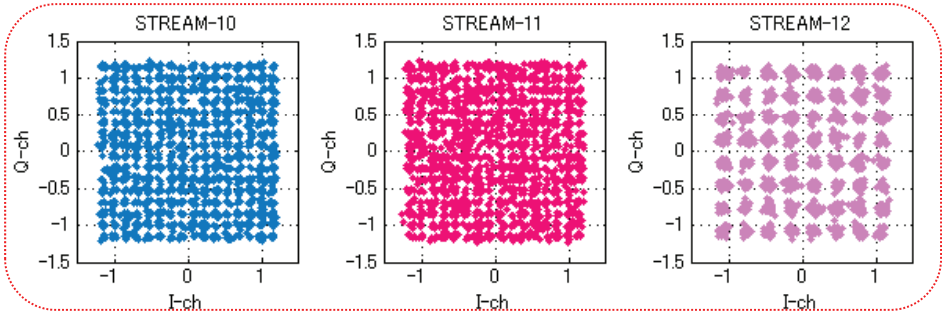
STA-2
(11 bit/s/Hz (220Mbps), R=7/8)



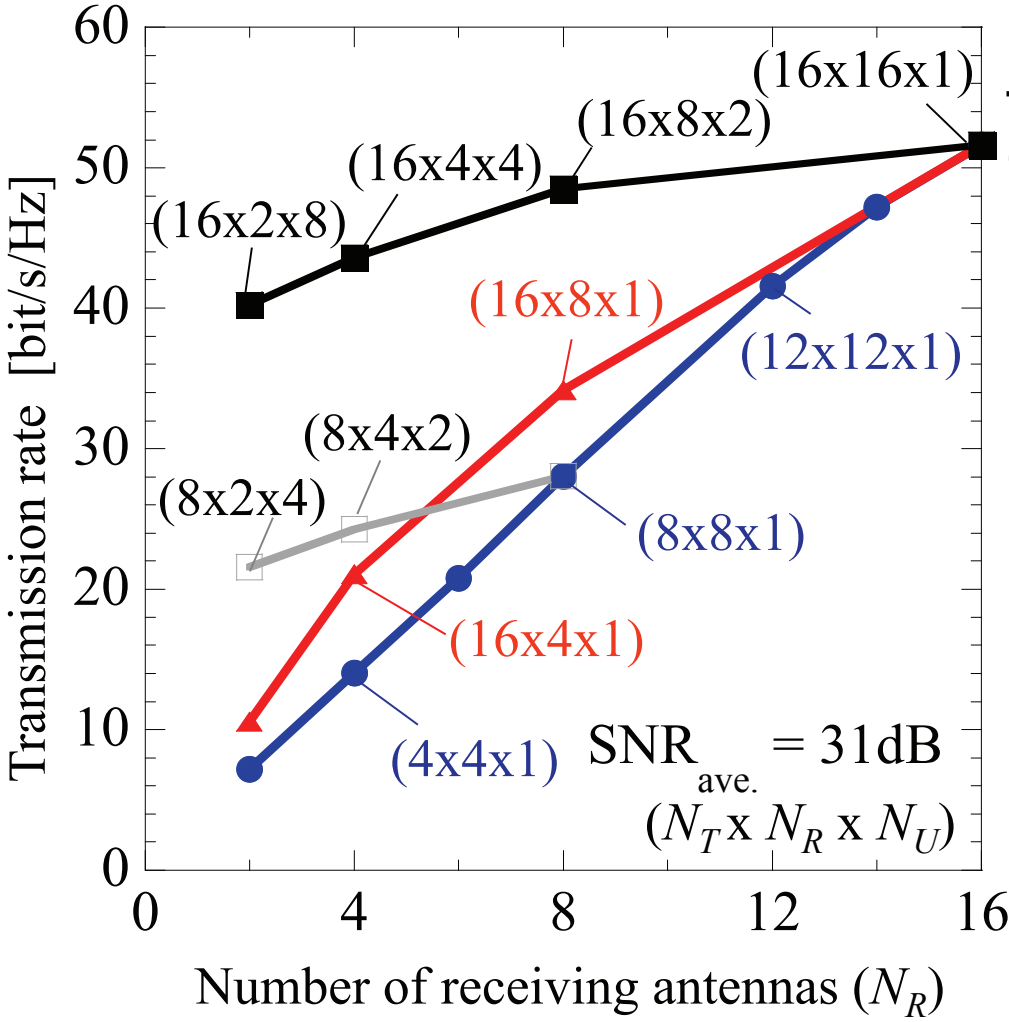
STA-3
(11 bit/s/Hz (220Mbps), R=7/8)

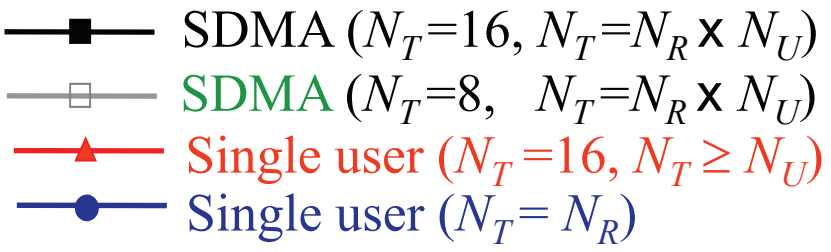


STA-4
(11 bit/s/Hz (220Mbps), R=7/8)



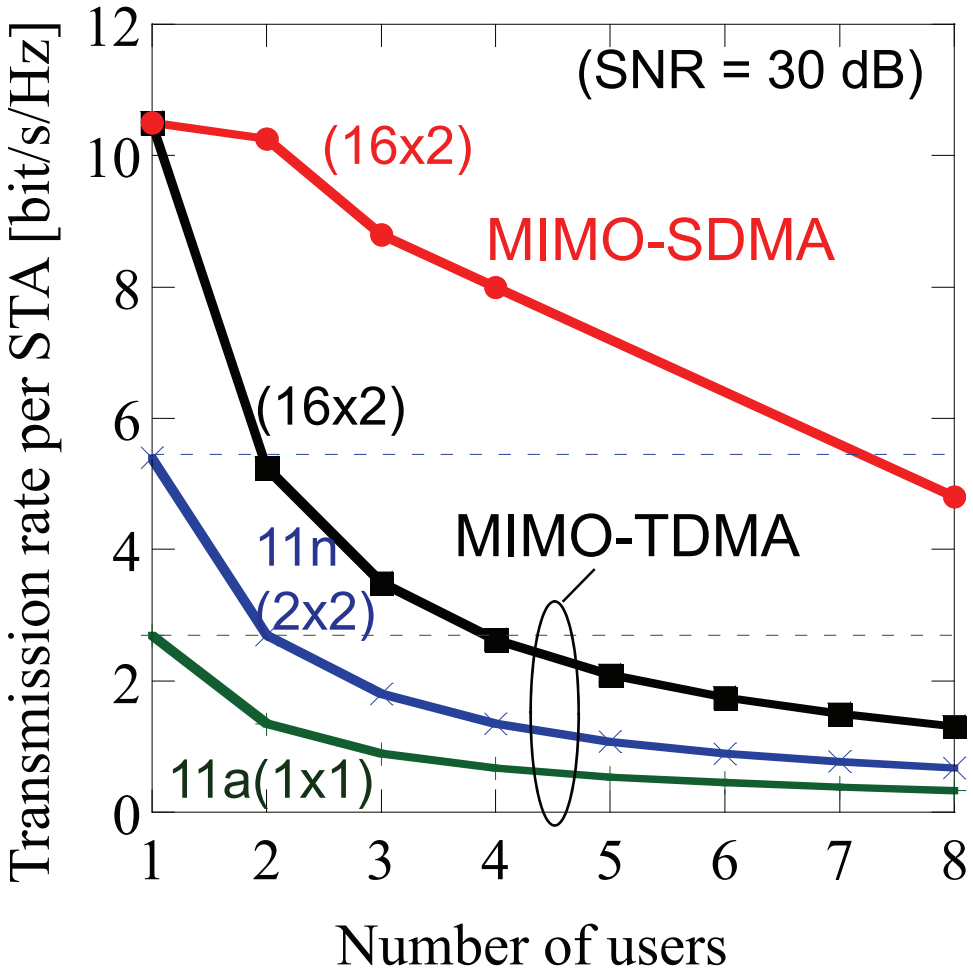
Transmission Rate vs. Number of Receiving Antennas in a Static Office Environment





- Spectrum efficiency strongly depends on the number of antennas at AP.
-Even with 2 or 4 antennas at each STA, **20bit/s/Hz** (N_R=8) and **40bit/s/Hz** (N_R=16) were attained.

Transmission Rate per STA vs. Number of STAs



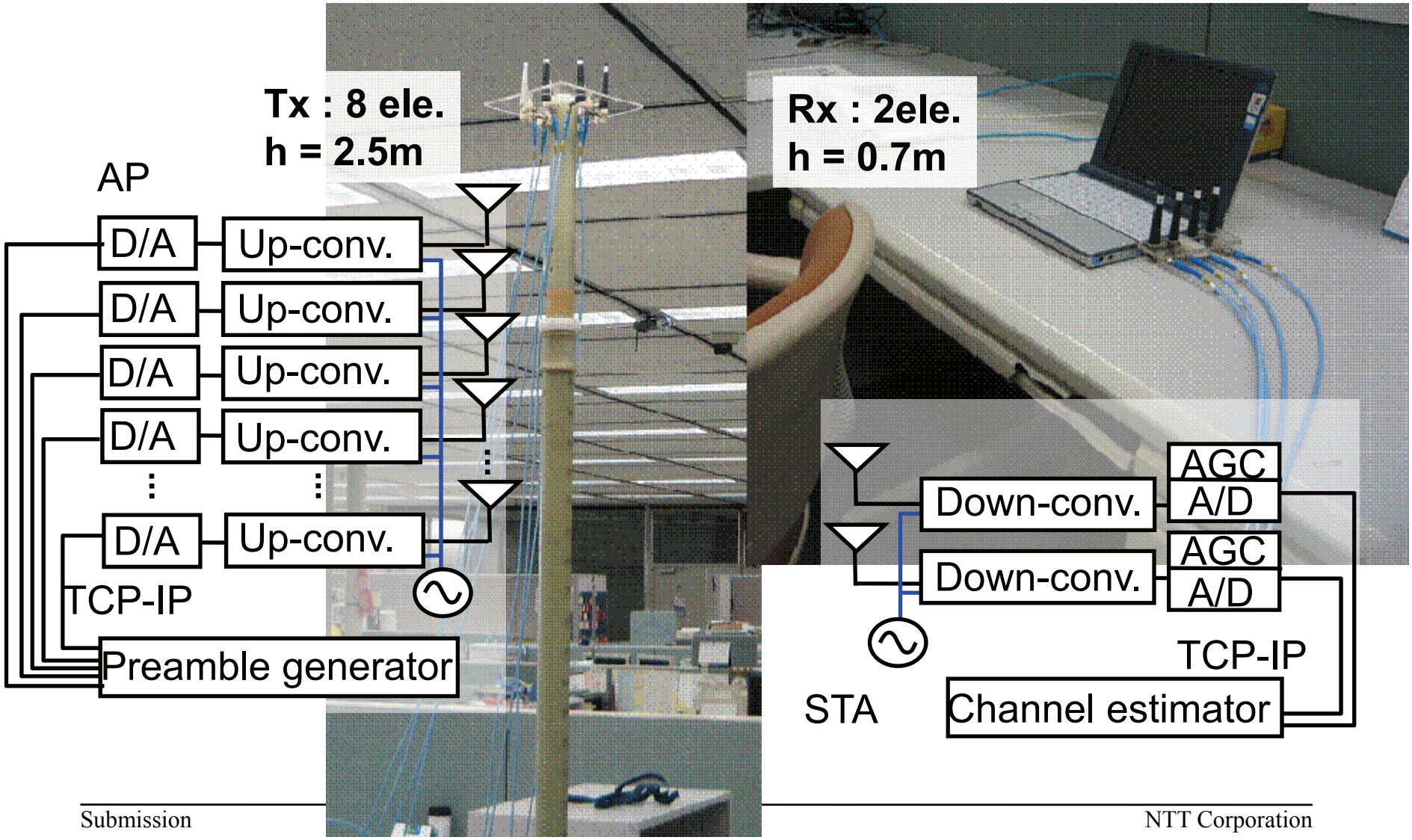
MIMO-TDMA

Transmission rate becomes R_s / U. U: Number of users

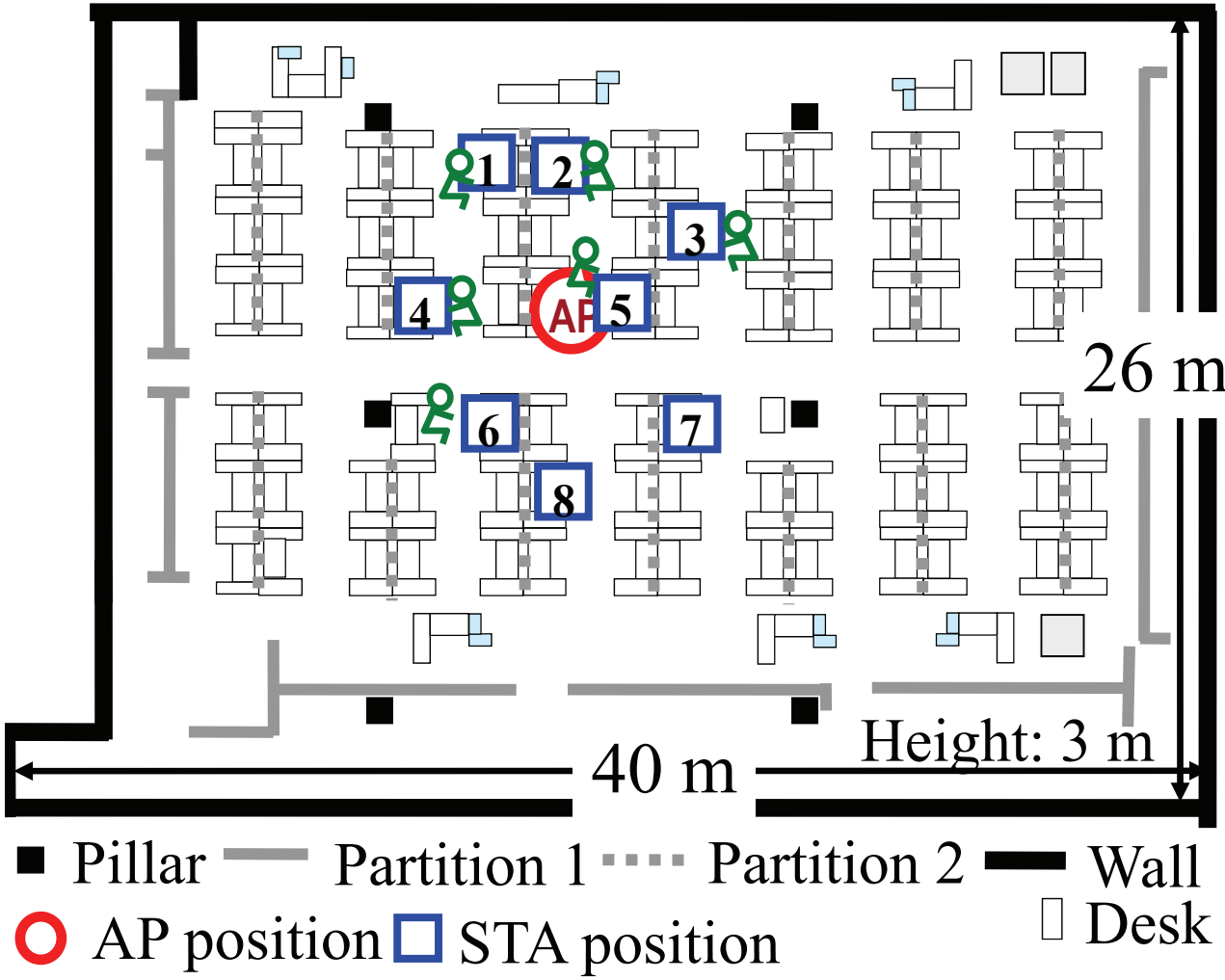
MIMO-SDMA yields a higher transmission rate than MIMO-TDMA, when the number of users is increased.

Contents

Evaluation in time variant channel



Environment for the measurements

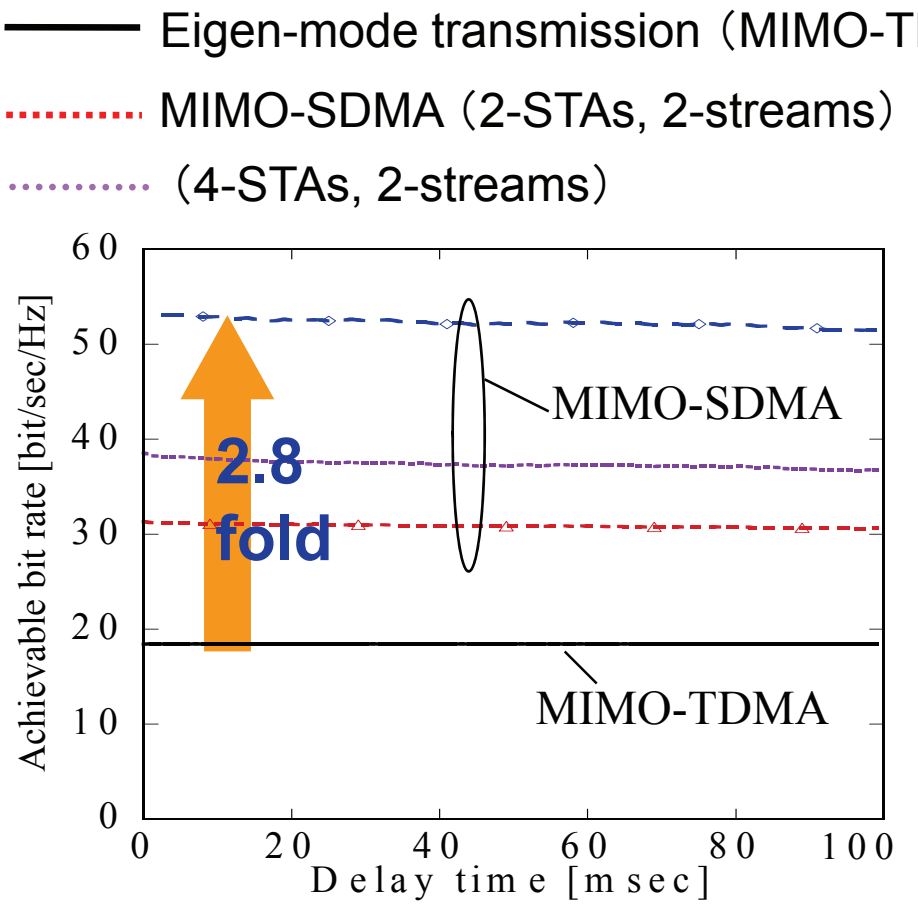


CSI is obtained from AP to P1~P8.
→ $\mathbf{H}_1(t) \sim \mathbf{H}_8(t)$
$(0 \leq t \leq 100\text{msec})$

1) Without person in front of each STA
2) With person in front of each STA

Capacity in time variant channel (1)

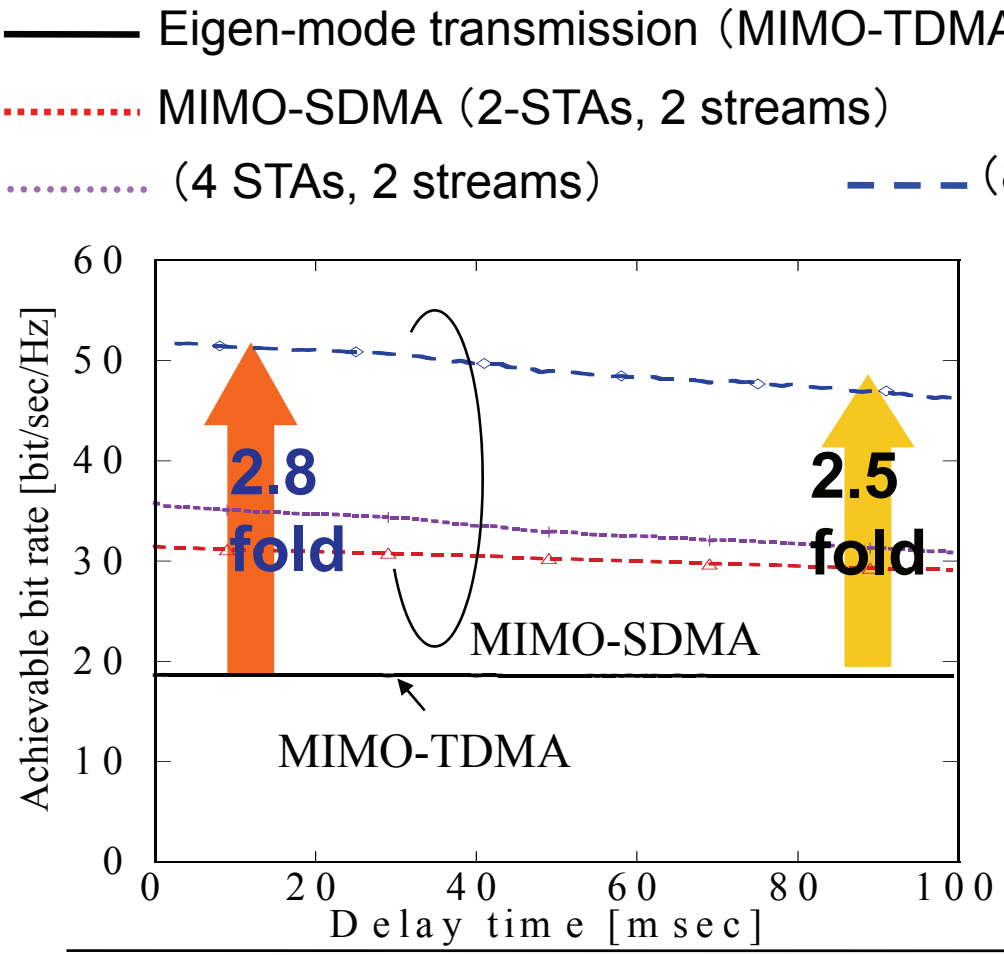
Without person in front of each STA.



- MIMO-SDMA attains 2.8-fold improvement over MIMO-TDMA.
- Slight fall off in ABR is observed with MIMO-SDMA.

Capacity for time variant channel (2)

With person in front of each STA.



- MIMO-SDMA attains 2.5-2.8 fold improvement over MIMO-TDMA.
- Slight fall off in achievable bit rate is observed with MIMO-SDMA.

Contents

Conclusions

- **SDMA can be important technology in TGac**
  - 40 bits/s/Hz frequency utilization efficiency was achieved with 16 antennas @ AP and 2 or 4 antennas @ MT.
  - 20 bits/s/Hz frequency utilization efficiency was achieved with 8 antennas @ AP and 2 or 4 antennas @ MT.

- **Time-variant channel was measured: indoor environment**
  - Small effect of the human body on the bit-rate was observed.
  - The bit-rate deterioration can be alleviated by reducing the number of streams.

- **These results support the feasibility of SDMA, yet TGac channel models should consider time-variant characteristics with spatially multiplexed STAs.**