[Propagation measurements and considerations in conference room, living room and cubicle environments Part 1]

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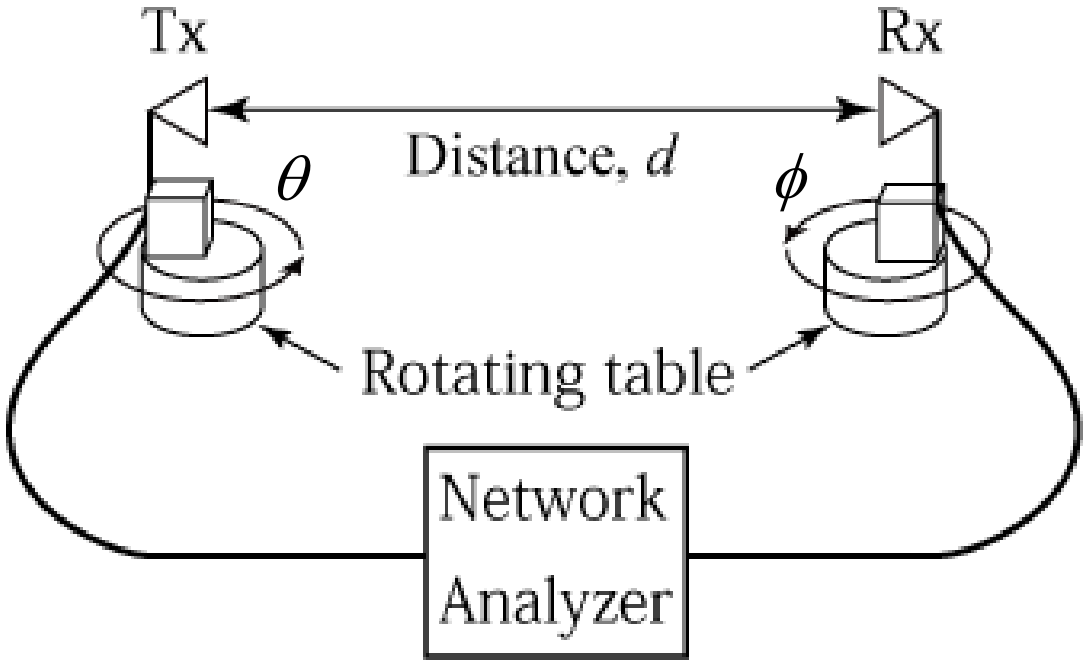
Abstract

[This document describes propagation measurements and considerations in conference room. We would like to share our measurement results to try to help TGad channel modeling.]

Contents

- **Measurement results and consideration of the double directional propagation characteristics for all three environments (Conference room, living room and cubicle environments) defined by TGad will be shown.**
- **In the presentation of Part 1, measurement results in conference room are explained.**

Measurement system

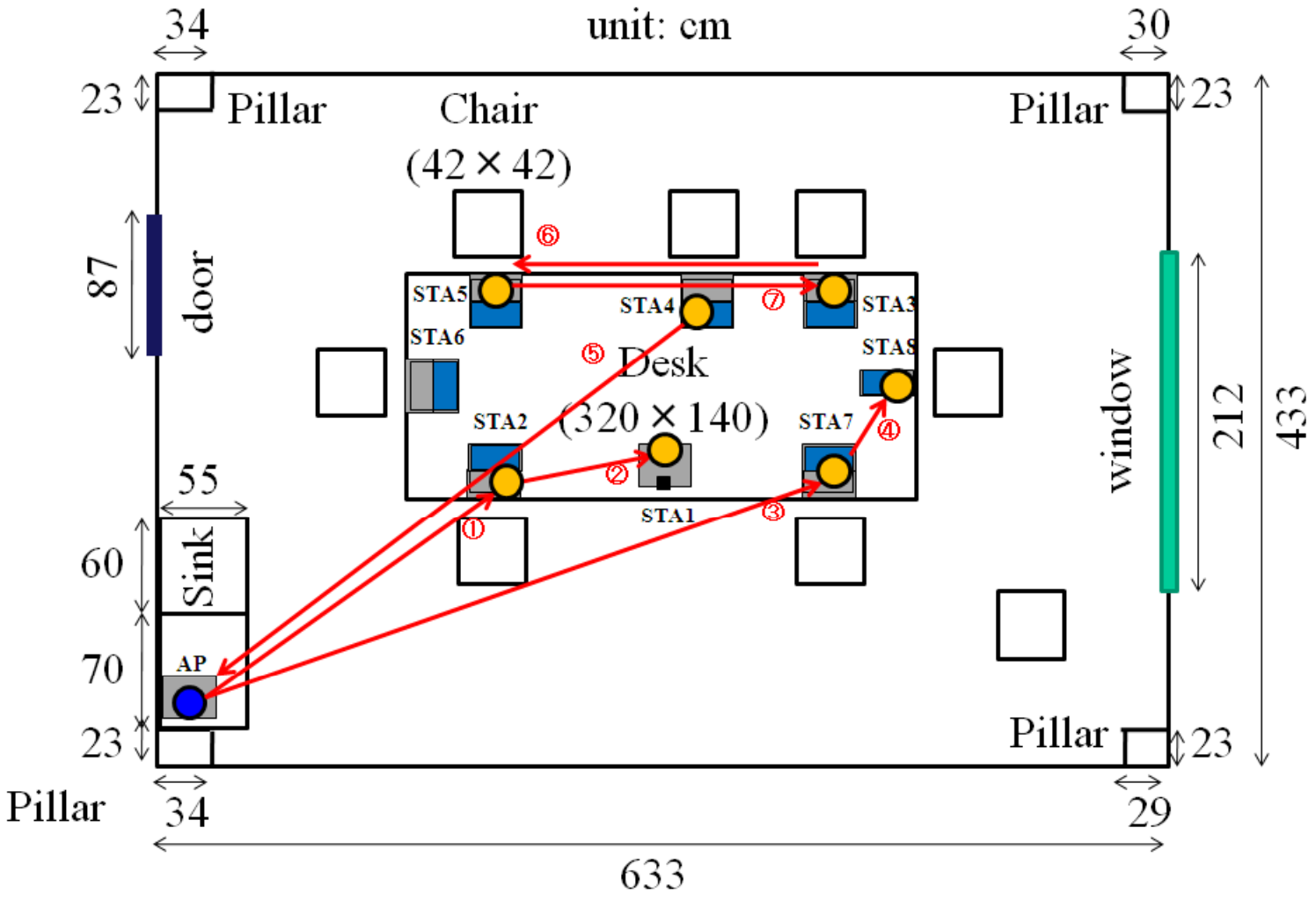


- Instrument: Vector network analyzer
- Antenna: Conical horn antenna

Measurement set up

Parameter	Value
Center frequency	62.5 GHz
Band width	3 GHz
Number of frequency points	801
Frequency step	3.75 MHz
HPBW of antenna (Gain)	60 degree for AP(10dBi) 30 degree for STA(16dBi)
Polarization	Co-polarized signal: Vertical / Horizontal / Circular Cross-polarized signals: V→H, H→V
Calibration	Direct port connection without antennas

Floor Plan of Conference Room



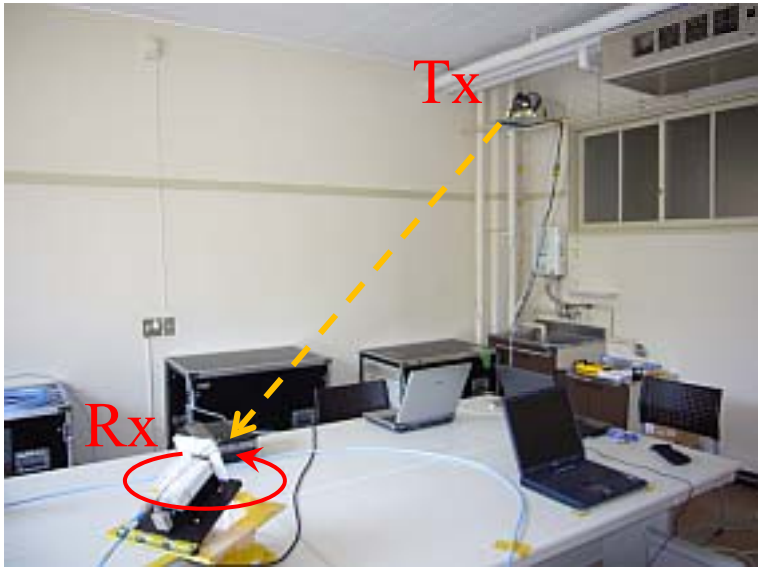
Scenarios in Conference Room

Scenario	Configuration	Measured CIR※ and frequency domain response
①AP → STA2	Tx is fixed and aligned to the center of table Rx is aligned to Tx	AoA※
②STA2 → STA1	Tx and Rx are aligned each other	AoA, AoD※
③AP → STA7	Tx is fixed and aligned to the center of table Rx is aligned to Tx	AoA
④STA7 → STA8	Tx and Rx are aligned each other	AoA, AoD
⑤STA4 → AP	Measured by reversed link AP→STA4 Tx is fixed and aligned to the center of table Rx is aligned to Tx	AoA
⑥STA3 → STA5	This is a reversed link of STA5 → STA3, thus this measurement is omitted	AoA, AoD
⑦STA5 → STA3	Tx and Rx are aligned each other	AoA, AoD
⑧STA5 → STA3	Tx and Rx are aligned each other Direct path component is blocked by notebook PC	AoA, AoD

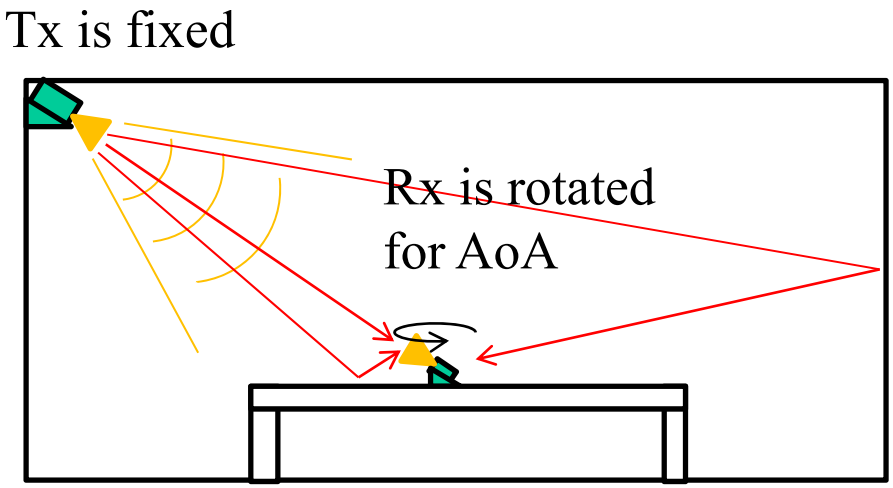
※CIR: Complex Impulse Response
※AoA: Angle of Arrival, AoD: Angle of departure

AoA only AoA and AoD

AP-STA Communication Link



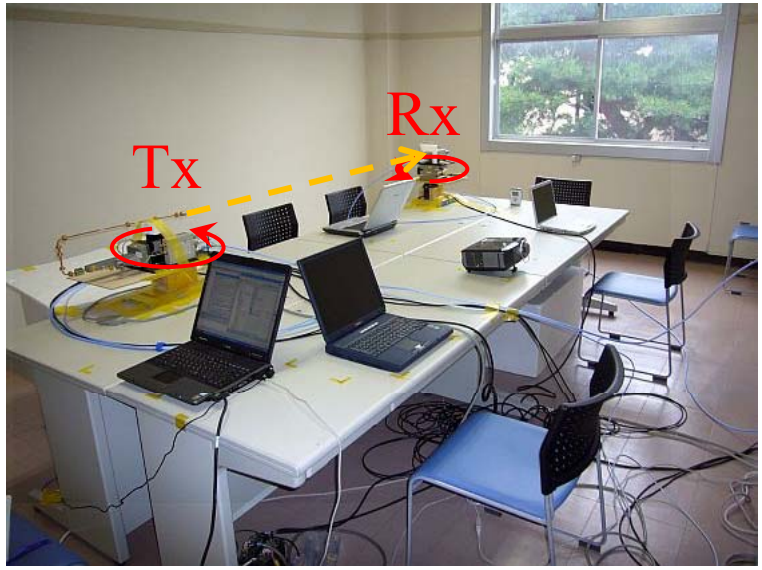
AP-STA link



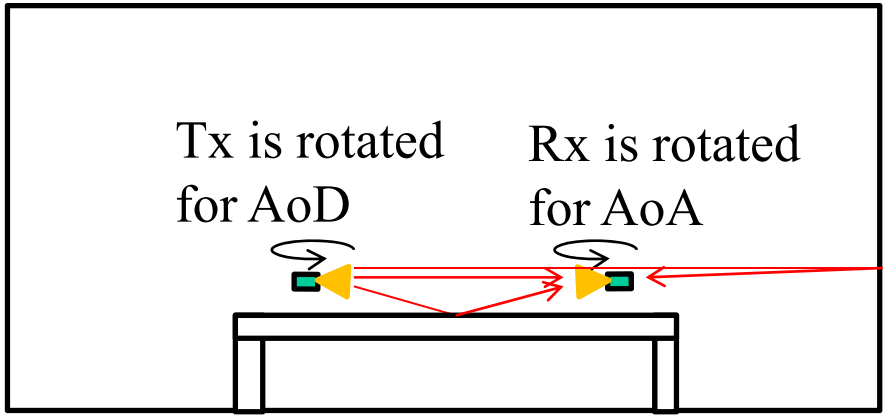
Measurement configuration

- HPBW of Tx antenna is 60 degrees, it covers all desktop area.
- Single directional propagation channel which Tx antenna was fixed were measured for each AP-STA communications.

STA-STA Communication Link



STA-STA link

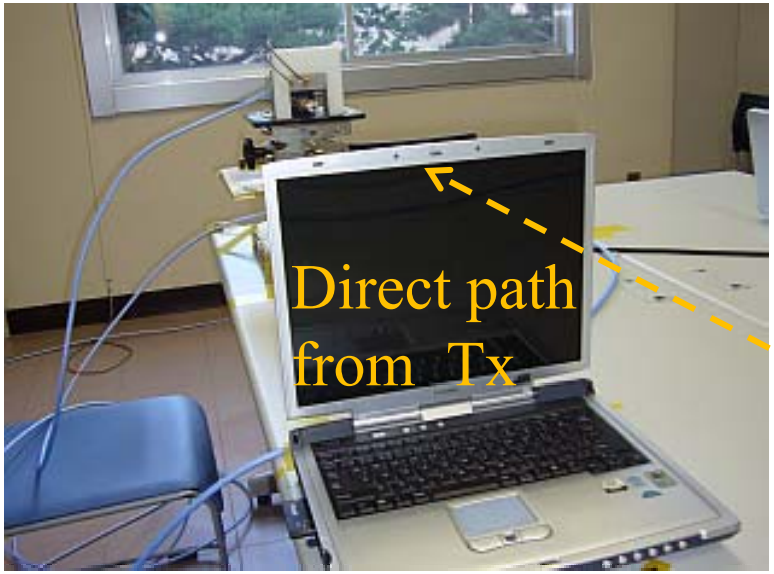


Measurement configuration

- Double directional propagation channel was measured for each STA-STA communications.

LOS/NLOS Scenario for STA5→STA3 Link

LOS scenario



NLOS scenario

- NLOS scenario was also measured as the direct path component was blocked by notebook PC.

Transmission Characteristics of Polarized Signal Waves

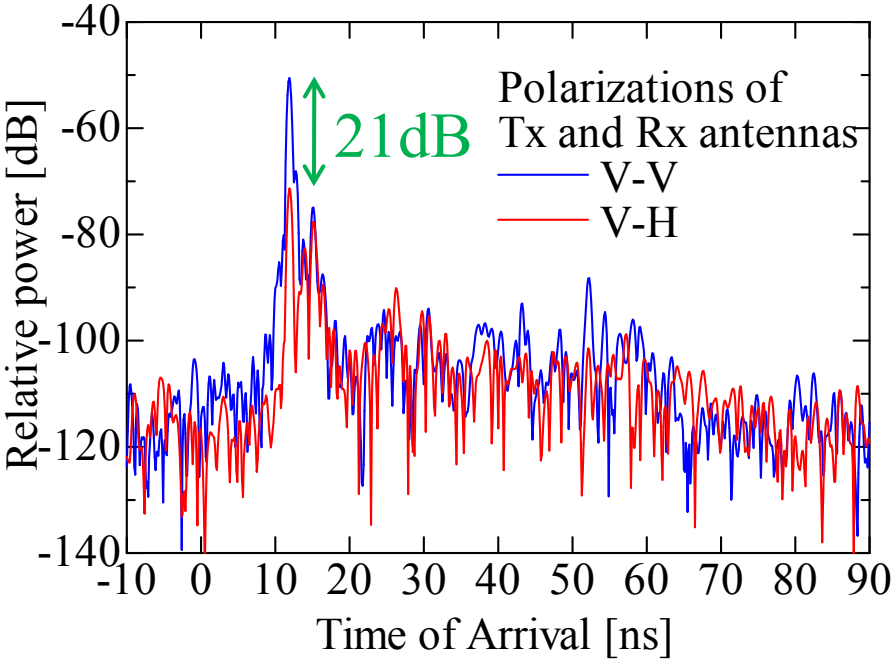
$$S_{ij} = S_{VV}, S_{HV}, S_{VH}, S_{HH}, S_{CC}$$

i : Polarization of receiving signal
j : Polarization of transmitting signal

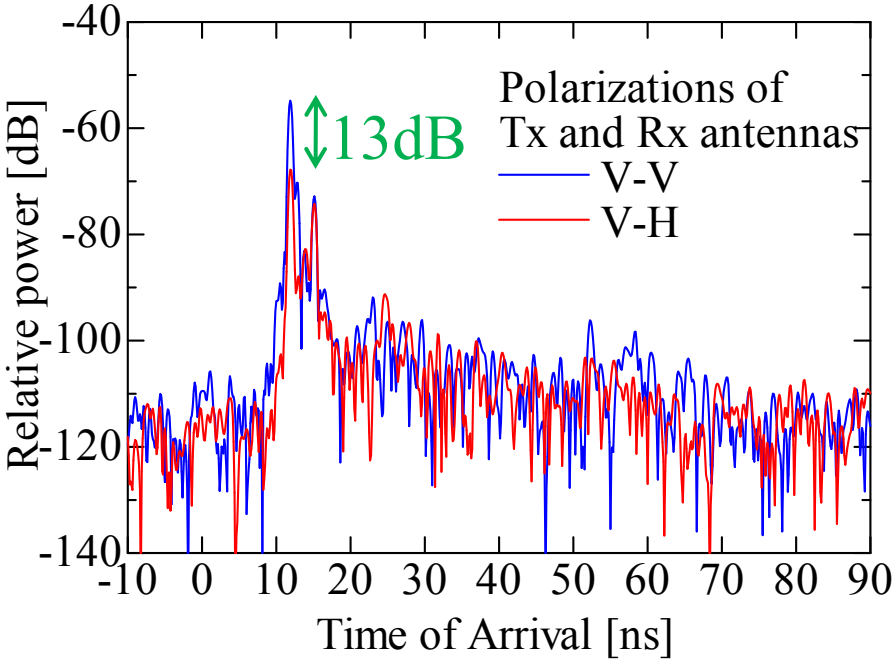
Polarization
V: Vertical
H: Horizontal
C: Circular

- Measurements were carried using polarized signal waves to investigate the feasibility of dual polarized signal transmission and polarization diversity systems

Example of Impulse Responses of Link5



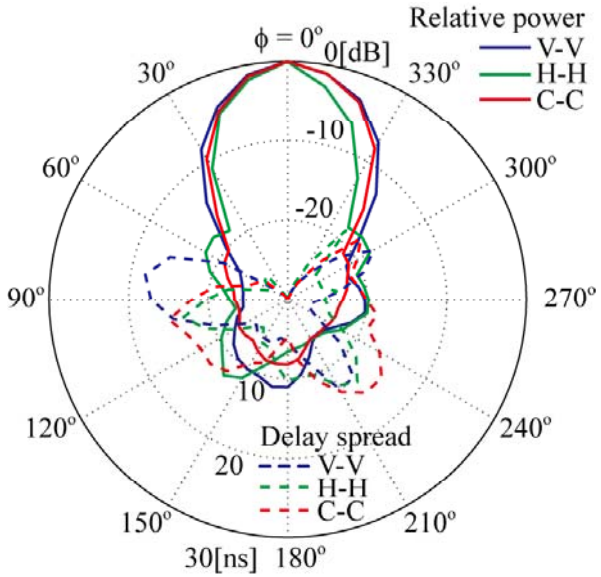
(a) AoD=0deg, AoA=0deg



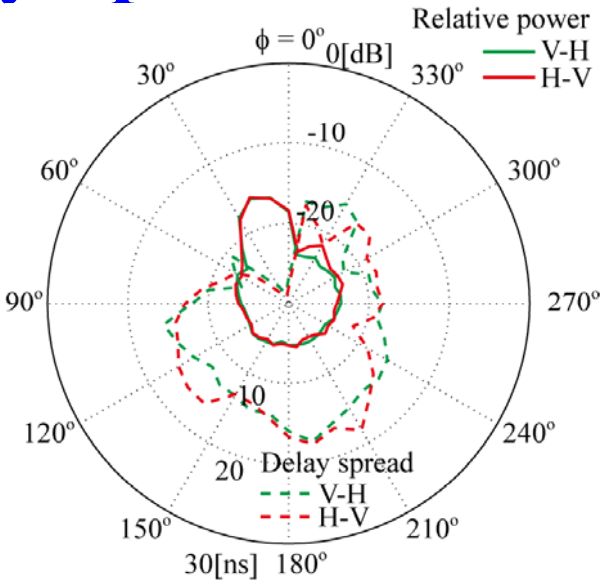
(b) AoD=20deg, AoA=0deg

- Peak power difference between S_{VV} and S_{VH} depends on the antenna's XPD characteristics.
- In this case, the difference was 21dB at the direct path, and 13 dB at 20 degree offset angle from the direct path.

Received Power and Delay Spread of the Link5



(a)Co-polarized signal waves



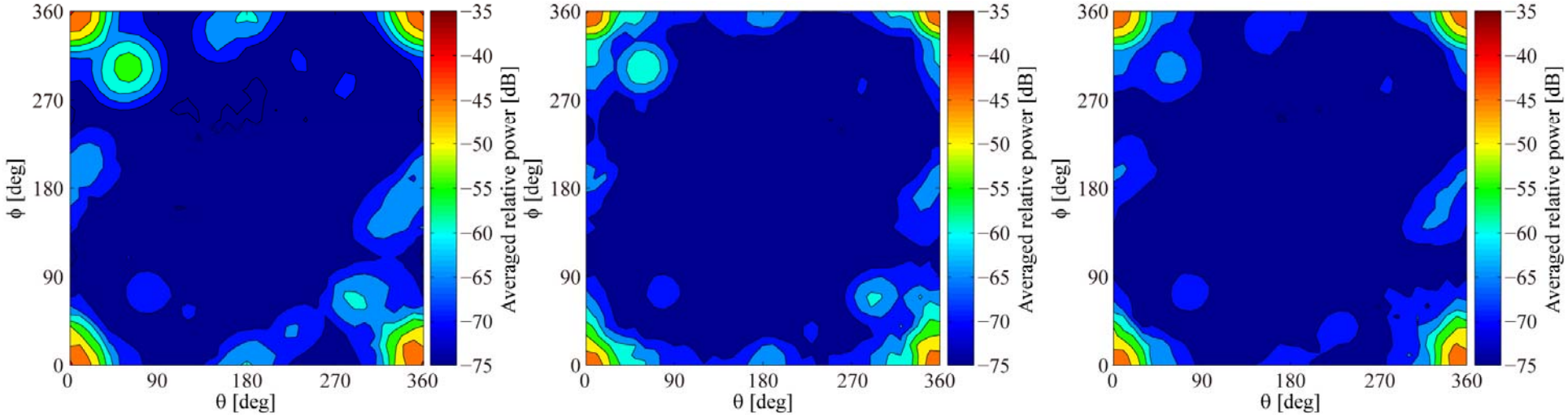
(b)Cross-polarized signal waves

※All relative power were normalized by the maximum power level of V-V.

Threshold level for delay spread calculation is less than 30dB from the peak power.

- The AWGN channel model is acceptable for the evaluation, since AP-STA link can keep LOS situation basically.
- Received power of cross-polarized signal waves increased around the direct path direction. This is the effect of XPD characteristics of the conical horn antennas.

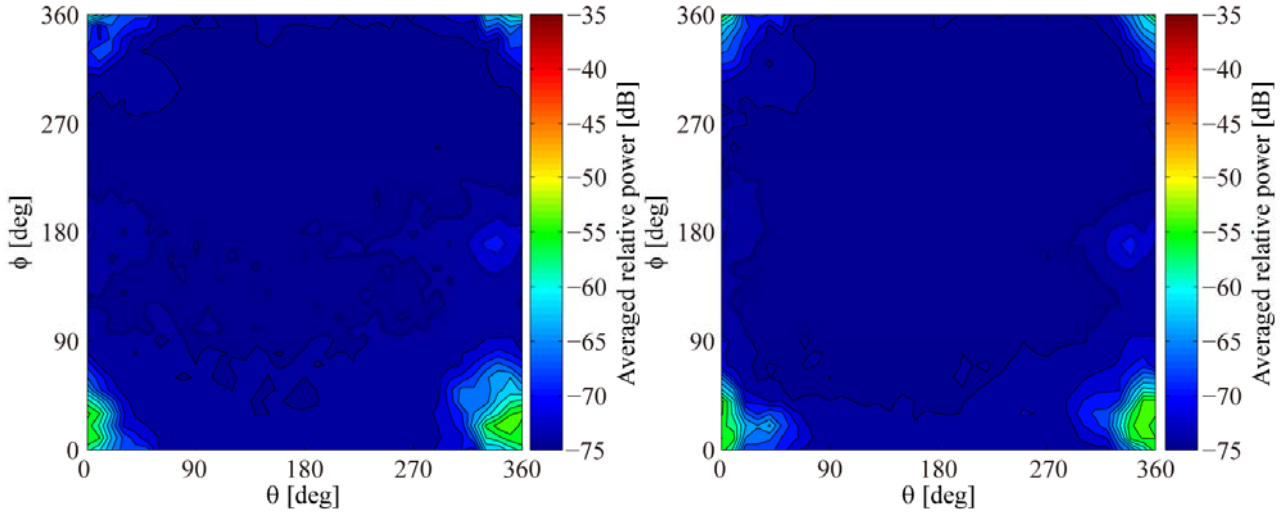
Relative Received Power of the Link7 (LoS) for Co-polarized Signal Waves



V-V H-H C-C

- The high received power positions (AoA and AoD) were almost same.
- Excluding direct path component, the such reflection power level depends on polarization.

Relative Received Power of the Link7 (LoS) for Cross-polarized Signal Waves



V-H H-V

- Received power increased around the direct path direction by the effect of XPD characteristics of the antennas.
- XPD components were not generated in propagation path.
- Thus the power of cross-polarized wave depends on antenna characteristics.

Summary

- The double directional propagation characteristics for all three environments were measured. In the presentation of Part 1, measurement results in conference room were explained. We will update the document to include the results of other environments.
- Dual polarized signal waves communication has some feasibility for a fixed wireless link, however, the interference level (S_{VH}, S_{HV}) depends on the antenna's XPD characteristics.
  → Antenna models with polarization will be required, if we consider such a system.
- The parameters of the path-loss model and impulse response model will be extracted for the TGad channel model.