

Invitation to jointly develop a proposal for ASEAN-IVO



Millimeter-Wave Wireless Systems during Severe Weather Conditions in ASEAN Regions

Y.N. Wijayanto, A. Kanno, T. Kawanishi,

Indonesia Institute of Sciences, Indonesia

Natl. Ins. Information and Communication Tech., Japan

Waseda University, Japan

Lembaga Ilmu Pengetahuan Indonesia

Indonesian Institute of Sciences

<http://lipi.go.id>

Microwave for 4G Mobile



- Up to 1–2 Gbit/s
- Distance >10 km

Suitable for backhaul link for 4G LTE

Pros.:

- Conservative technologies

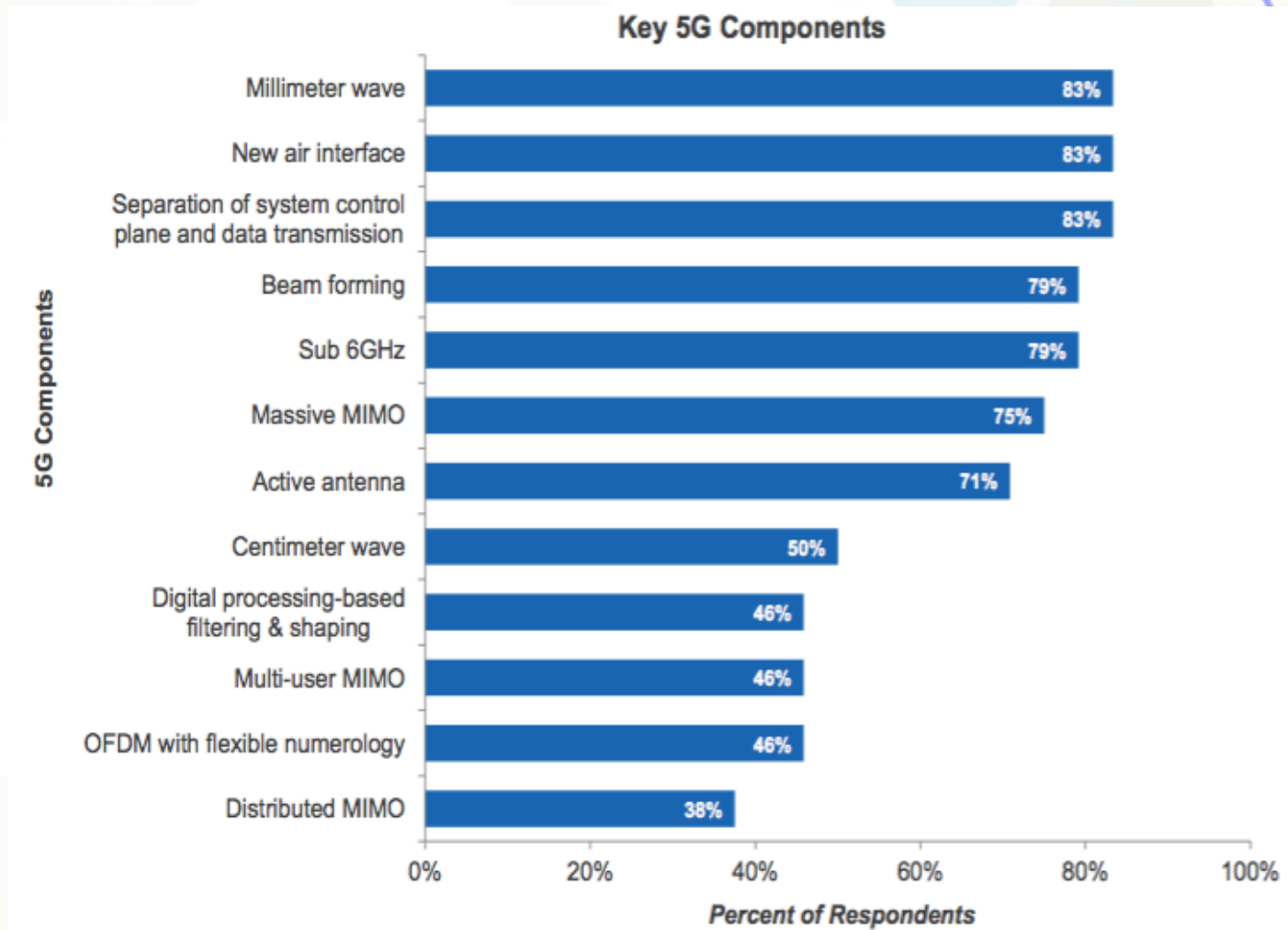
Cons.

- Large dish (heavy weight)
- Low speed

Ericsson, Microwave enables LTE in remote areas

<https://www.ericsson.com/en/networks/cases/microwave-enables-lte-in-remote-areas>

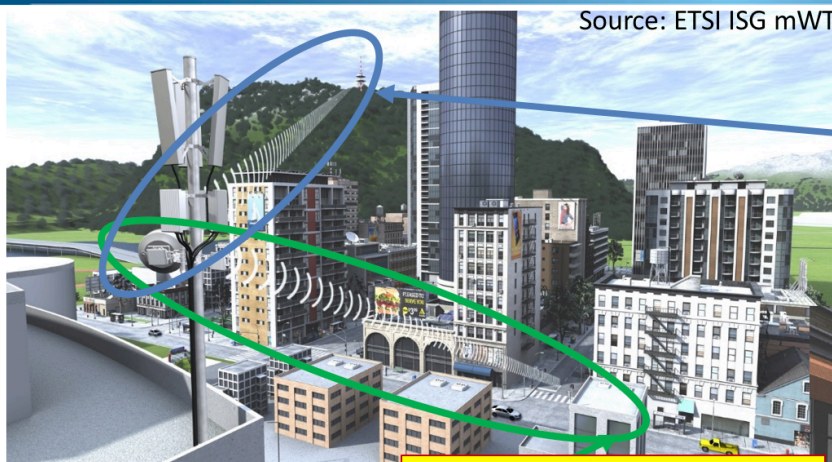
Key 5G Components



Millimeter-Wave Supporting for 5G Mobiles



Network Densification mmW in Urban Environment



Source: ETSI ISG mWT

Macro Backhaul and Aggregation

■ Roof-top to Roof-top

- Traditional planning, co-located with Macro
- Part of Macro Backhaul

E-band (71 to 76 - 81 to 86 GHz)

Small Cell Backhaul

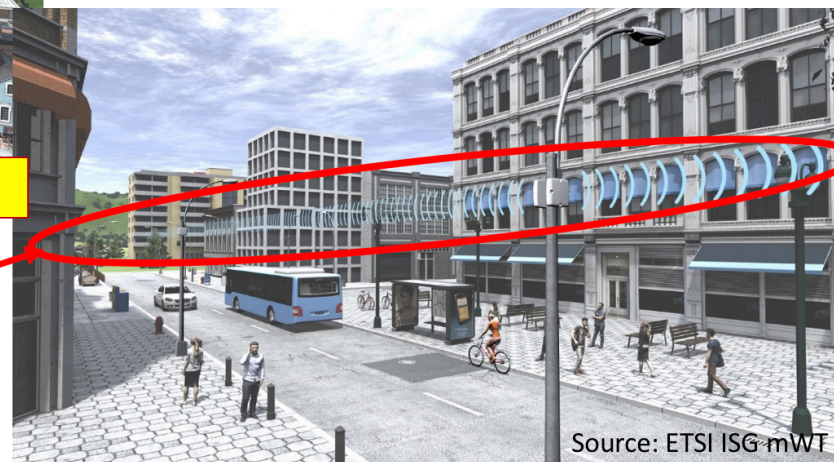
V-band (57 to 66 GHz)

■ Macro to Street-Level

- Form factor must be suitable for Small Cell
- Traffic from a few Small Cells may be aggregated

■ Street-Level to Street-Level

- Links will often be almost parallel to each other
- LoS may be challenging in urban environment



Source: ETSI ISG mWT

D. Gentina, "Backhaul Challenges & Evolution Trends: THE Role of mmW," ETSI ISG mWT meeting, Nov. 2017

Millimeter-Wave Equipment



NEC Corp.

- E-band (71-76, 81-86GHz)
- 10 Gbit/s by single antenna
- 20 Gbit/s by dual antennas

Antenna dish size:<30 cm

Weight: <6kg

i.e.) 6GHz FWS

- Dish size: >2m
- Weight:>10 kg

Application of Millimeter-Wave to ASEAN Region

Millimeter-wave radios can be strongly affected by weather conditions.

- Rain (water vapors and drops) increases attenuation.
- Strong wind induces vibration of the antennas.

ASEAN region:

- Tropical climate
- Indochina peninsula: Savannah climate by monsoon

Heavy rain (rainfall $>100\text{mm/h}$)

Squall (windspeed $>11\text{m/s}$)

Typhoon/cyclone

Severe
Weather
Condition

On-Going ASEAN-IVO Project

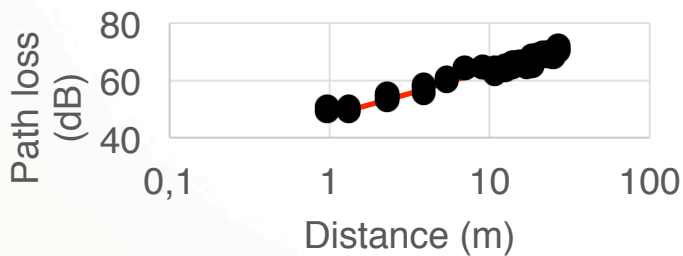
“R&D on short-distance communication and imaging for applications in ASEAN region (FY2016-2018)”

PI: Prof. Vo Nguyen Quoc Bao, PTIT, Vietnam

Related research items:

- Evaluation of mmWave communication systems for metro-train systems (PTIT, NICT)
- Empirical study of microwave FWS in severe weather conditions (PT. Telkom Indonesia, LIPI)
- Study on Electro-Optic Devices for millimeter-wave applications (LIPI, NICT)

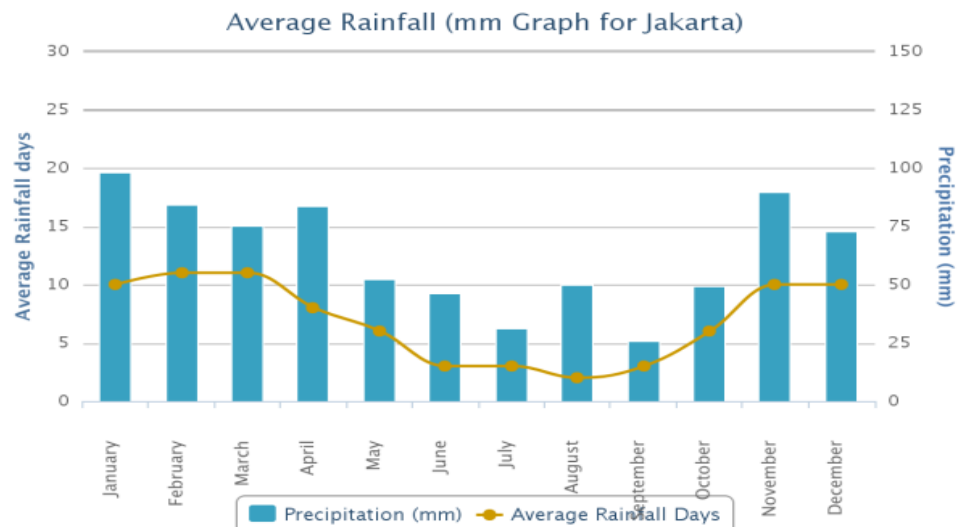
Results: 90GHz field trial in PTIT HCMC, Vietnam



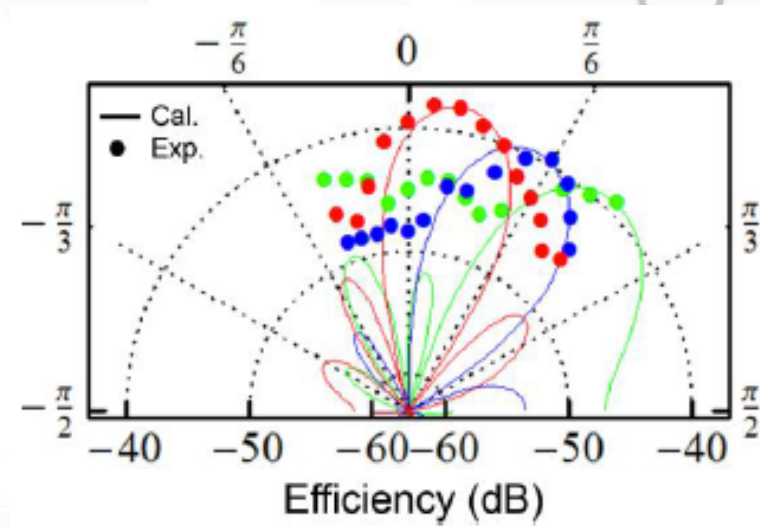
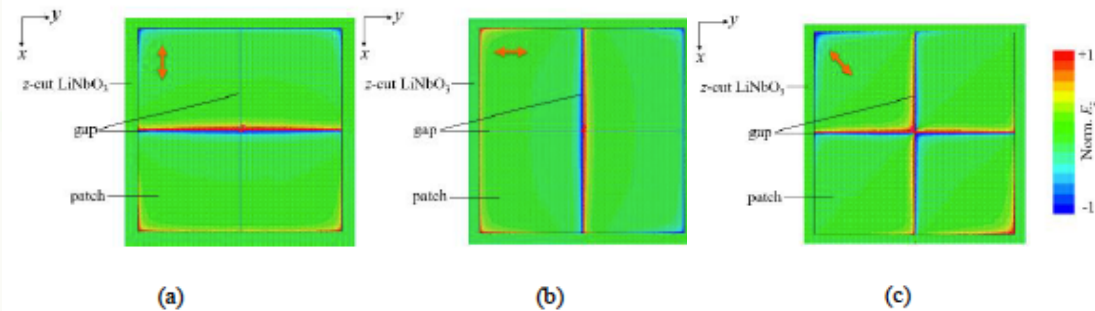
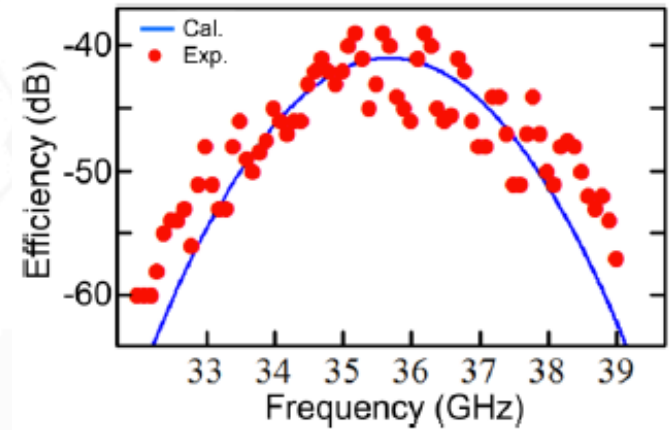
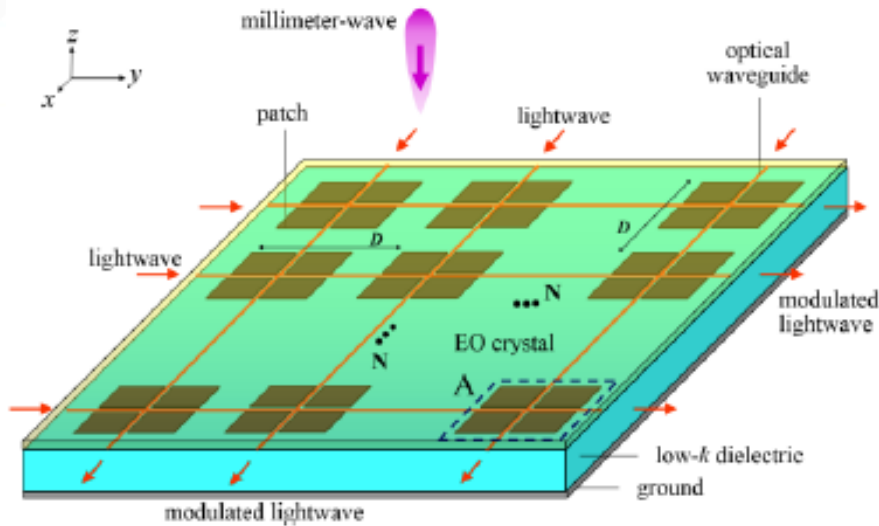
Deduction: Outdoor and long-term (>a month) evaluations are demanded.

Empirical study of microwave propagation

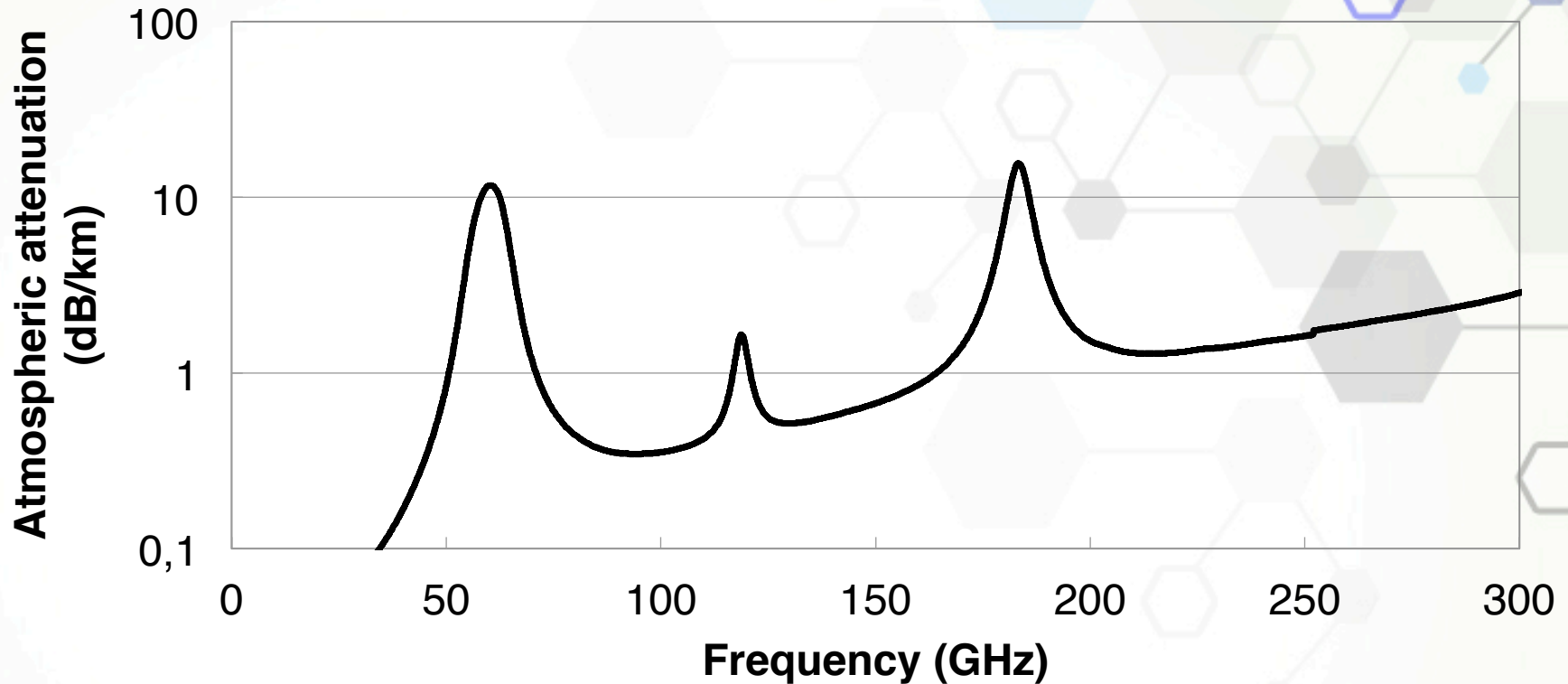
- Indonesia has a tropical climate. There are two seasons. The dry season with winds blowing from the Australia Continent, lasts from March to August and the wet season influenced by winds from the Asian Continent and the Pacific Ocean lasts from September to March with the heaviest rainfall usually from November to February.
- Average annual precipitation varies by area. The average annual precipitation (mm/year) for the major islands is presented below :
 - Sumatra: 2600
 - Java: 2600
 - Nusa Tenggara: 1500
 - Kalimantan: 2800
 - Sulawesi: 2100
 - Maluku: 2200
 - Papua: 3200
 - Total: 2700



Electro-Optic Devices for Millimeter-Wave Application



Atmospheric Attenuation

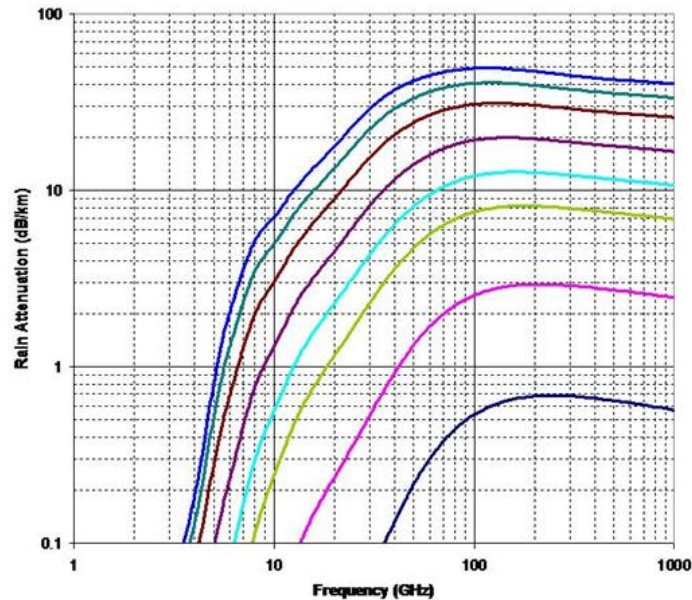


The Federal Communications Commission (FCC) ruled that spectrum at 71 to 76 GHz, 81 to 86 GHz and 92 to 95 GHz was available for high-density fixed wireless services

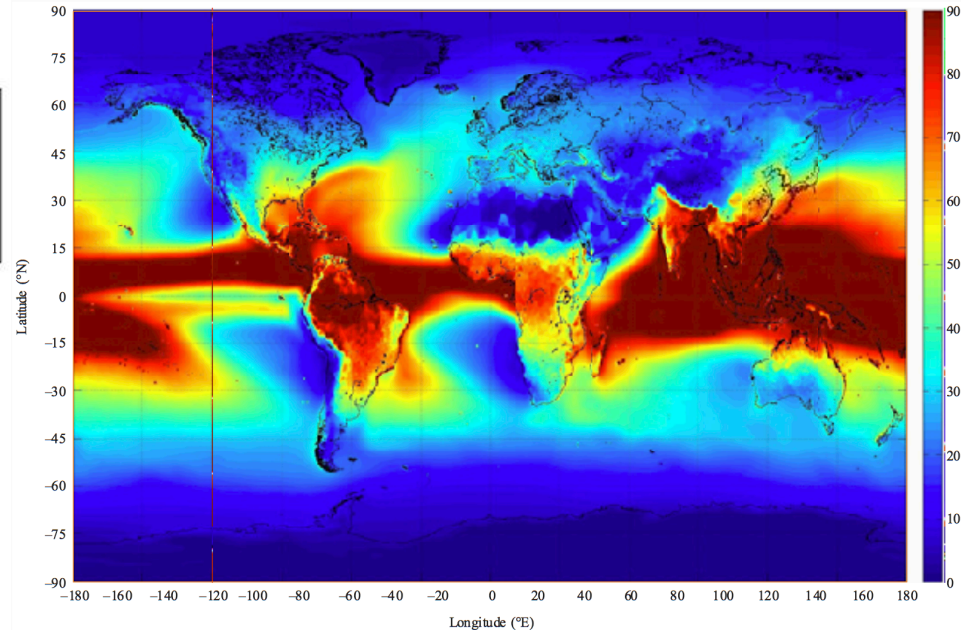
Rain Attenuation



Rainfall rate exceeded >0.01%



Source: E-band communications <https://www.e-band.com/index.php?id=86>



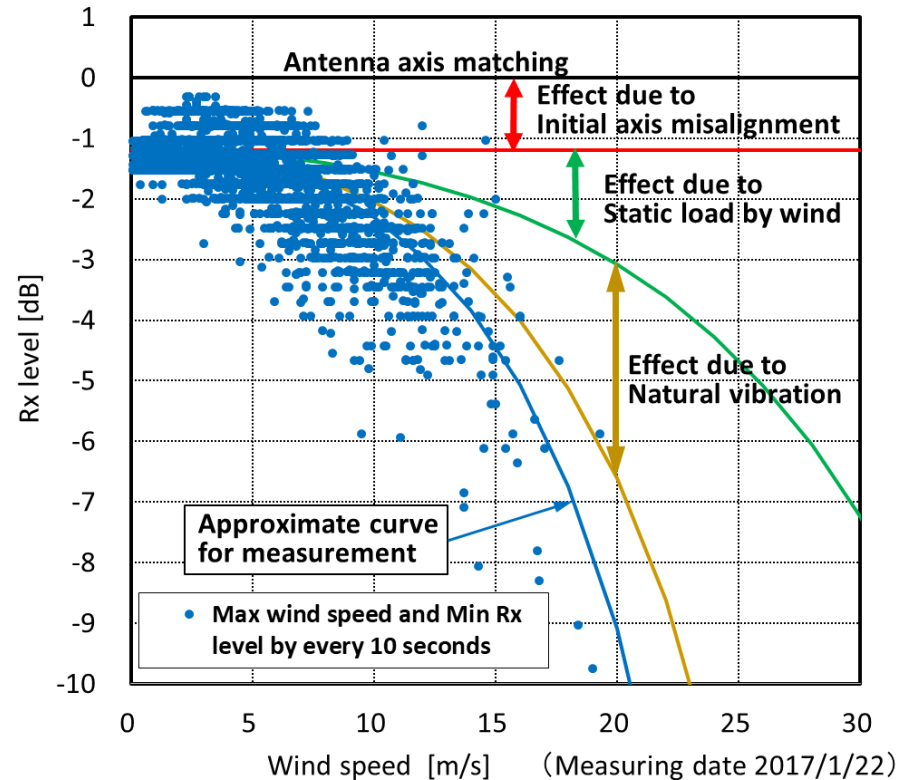
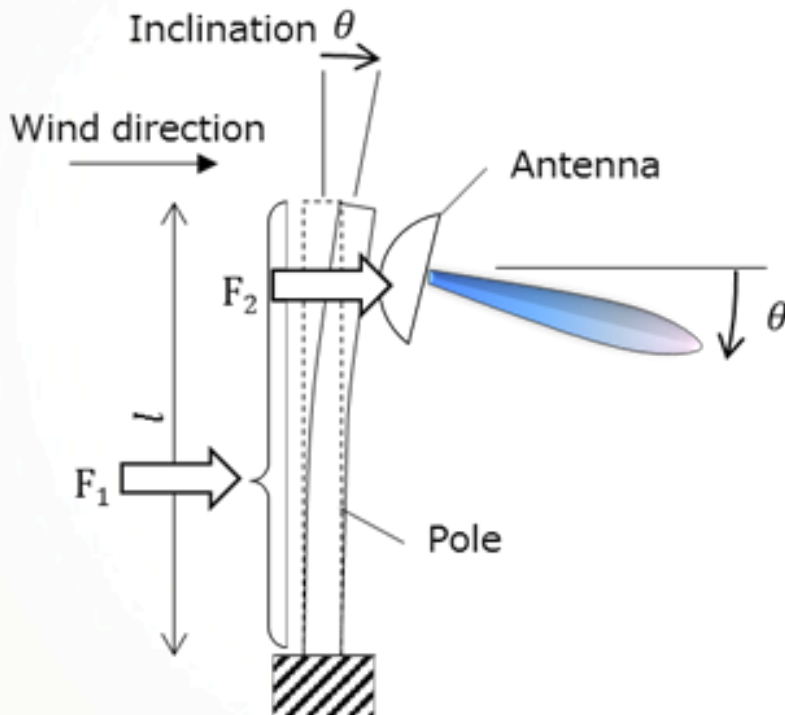
Rec. ITU-R P.837-7: Characteristics of precipitation for propagation modelling

Rainfall affect the millimeter-wave propagation

ASEAN Regions have heavy rainfall rate

Strong Wind Condition

Wind induces vibration of poles and antennas => Link gain degradation



From on-going standardization documents: APT/AWG-24 TMP-02 in TG-FWS

Research Plan

- Experimental evaluation of millimeter-wave transmission in the field
- Round-robin test in ASEAN region (Indonesia, Malaysia, Thailand, Vietnam, and so on)
- Application study for high-speed internet connection and backend network for high-precision radar system.
- Supporting a document for standardization in AWG, APT, ITU meeting

Possible collaborators:

- Millimeter-Wave equipment vendor: NEC Japan, Hitachi Kokusai Electric Japan
- Research institute: LIPI, UTM Malaysia, Mie Univ. Japan, Thailand, Vietnam, Telkom Indonesia, LAPAN Indonesia

Collaborator Candidate

- Millimeter-Wave equipment vendor:
 - NEC Japan
 - Hitachi Kokusai Electric Japan
- Research institute:
 - LIPI Indonesia
 - NICT Japan
 - UTM Malaysia
 - Mie Univ. Japan
 - CU Thailand
 - PTIT Vietnam
 - PT Telkom Indonesia
 - LAPAN Indonesia



Thank you
for your attention
yusuf.nur.wijayanto@lipi.go.id