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6G India 2023 INTERNATIONAL CONFERENCE
9th & 10th MAY 2023
LE MERIDIEN, NEW DELHI
2 DAYS CONFERENCE
1 DAY EXHIBITION

5G/6G technology – Advantages, Challenges and Solutions

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May 2023

Agenda

- Introduction and technology background
  - What is 6G and why is it considered so important?
- What frequencies are being considered for commercial 6G deployments and other applications
- Practical challenges and solutions for 5G/6G
- Anritsu solutions that are accelerating the fundamental research activities for 6G.

Introduction – The evolution

- Technology has surely taken a big leap forward
  - 2G : Voice services and data rates to 384Kbit/s
  - 3G : Data rates of 2 Mbit/s
  - 4G : Data rates to 1Gbit/s
  - 5G : Data rates up to 10Gbit/s
    - Enhanced mobile broadband (eMBB)
    - Ultra reliable and low latency communications (URLLC)
    - Massive machine type communication (mMTC)
    - AI (artificial intelligence and machine learning)
  - 6G coming up : Data rates of the order of 1 Tbit/s
    - Digital twin world,
    - Holographic calls , touch screen will go obsolete, and human would be talking to anything that is electronics !!
    - Non terrestrial network (5G/6G terminals in space)
    - Imaging, sensing, ultraprecision, gas detection etc.
    - Meta verse – Human to Avatar , Avatar to Avatar (virtual world will exist !!)
    - Extended reality experience through lightweight glasses

How did we reach here?

- Making use of the spectrum that was available and various modulation techniques, with whatever hardware we could built at the time.
- Lower frequencies – Lesser modulation bandwidth available – lower data rates
- Moving higher in frequencies : mm-wave, wider modulation bandwidth available – higher data rates and other advantages
    - Smaller size of the devices and higher speed of data
    - More number of antennas can be deployed for beamforming – massive MIMO
- Advantages of moving higher in the frequency
    - More spectrum with wider modulation bandwidth available – so more data rates
    - Efficiency is enhanced , less power-hungry devices
    - Smaller size of the devices and components like antennas etc.
    - To overcome the limited gain at higher frequencies new antenna technologies like massive MIMO and beamforming etc. to be utilized to make system have enough gain (practically an advantage)

Frequencies being considered for 6G and why?

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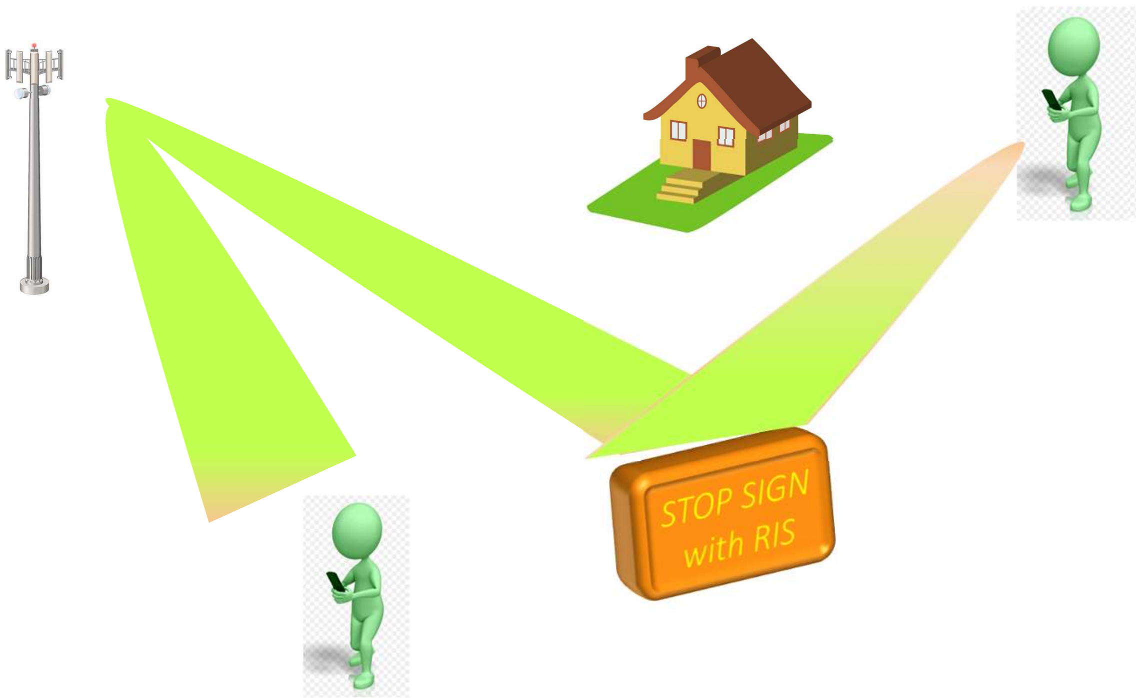
- Commercial 6G deployment (to support the “on to go” applications)
  - Lower frequencies to support mobile communications
    - Several candidates in the 7GHz to 24GHz range (in 5G we had FR1 and FR2 ranges)
      - Challenges –
        - Over the air losses for higher frequencies are too high
        - Material characterization
      - Solutions –
        - Low-cost base stations with beamforming and higher modulations techniques
        - RIS (Reconfigurable intelligent surfaces)
        - Material measurement solutions (Dk/Df)

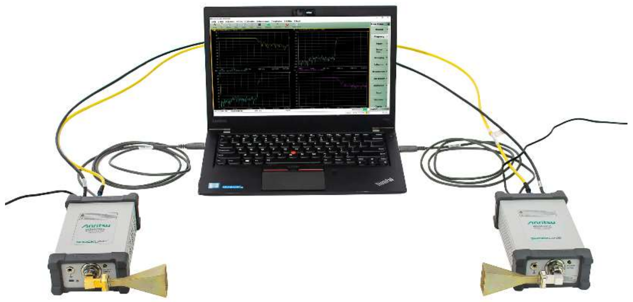
- Research on higher frequencies (Fronthaul/Backhaul , Sensing, imaging etc.)
  - D band (110-170GHz)
  - G band (140-220GHz)
      - Challenges
        - Accurate and precise device characterization of fundamental devices – Amps/filters/mixers
      - Solution
        - New instrumentation to support measurements

Lower Frequencies

Reflective Intelligent Surface/Channel sounding

- Beyond 5G and 6G would need new devices to take care of the signal propagation at extreme high frequencies.
- The biggest research area right now is focused on two things
  - Channel sounding : How would 6G signals react to the propagation channel and
  - Reflective intelligent surfaces and on antenna on display.



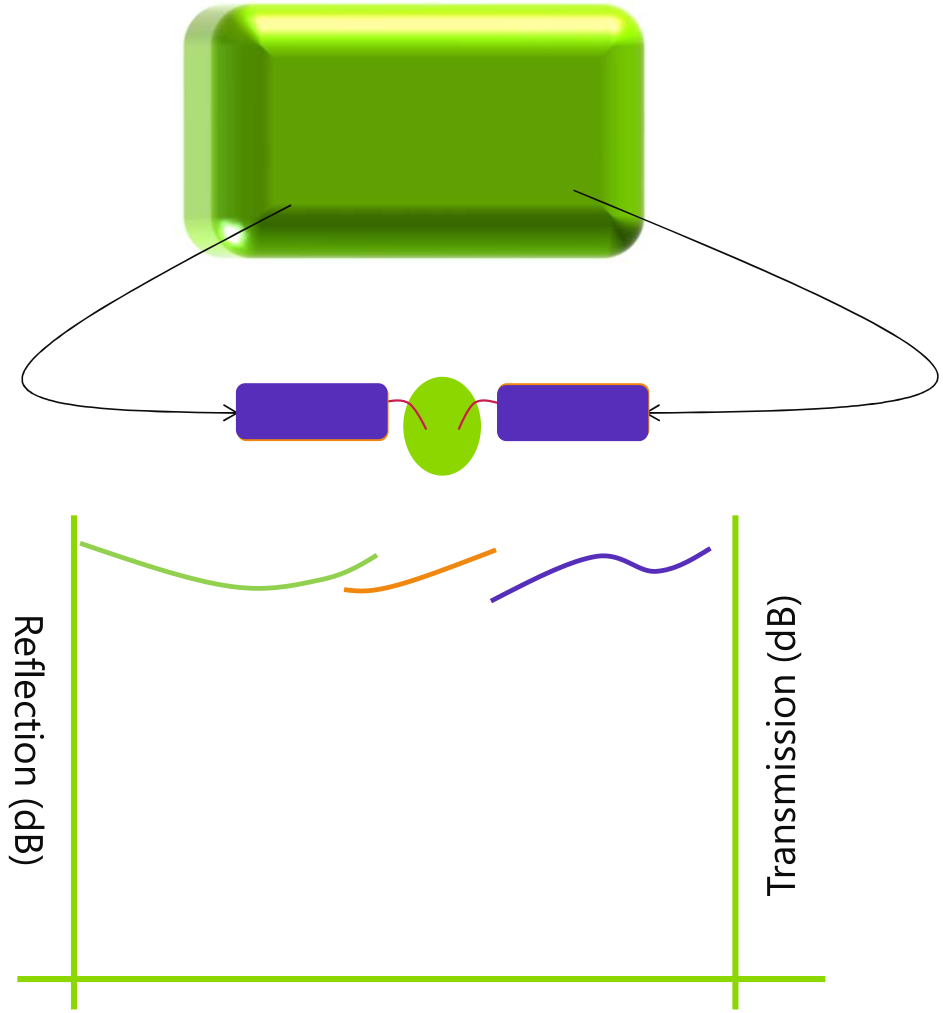


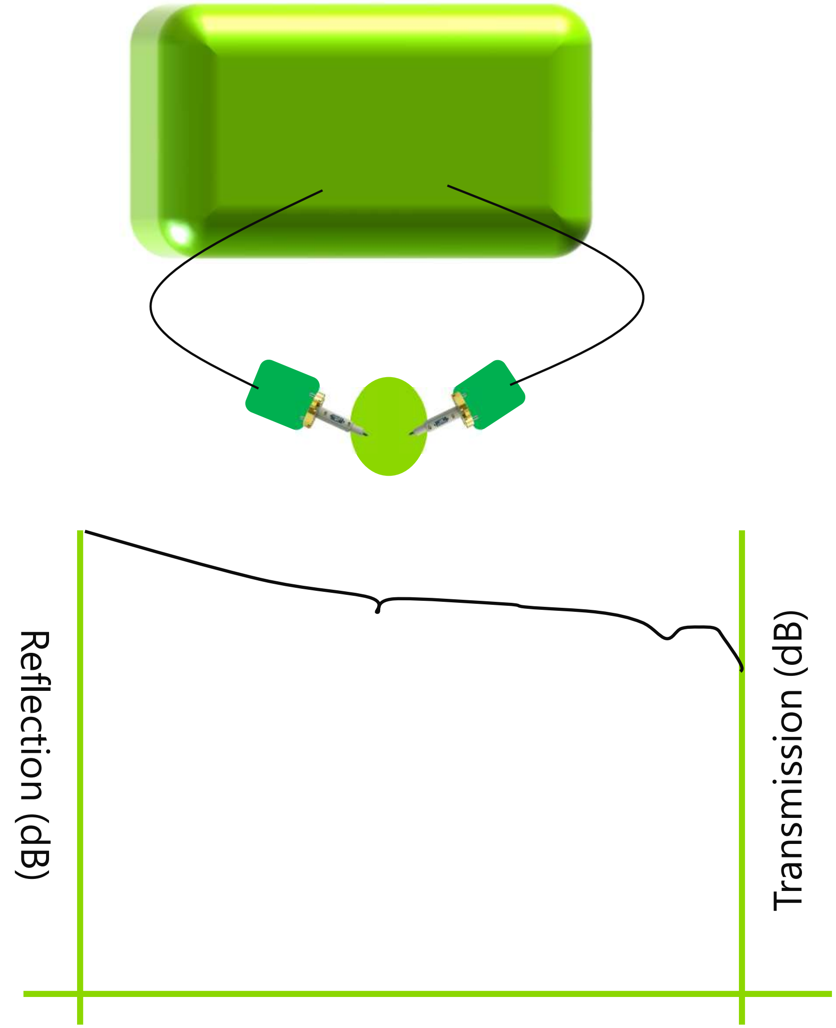
ME7868A - 2 port distributed VNA system

- Two ports of the VNA's separated by long distance 5m/25m/50m/75m/100m
- Full 2 port Vector corrected S parameter measurements
  - Magnitude and phase
- Ideal for testing
  - RIS
  - Channel sounding
  - Antenna measurements in Anechoic chambers
  - Outdoor antenna test ranges

Higher Frequencies – Challenges and solution

Challenges and solution of Device characterization

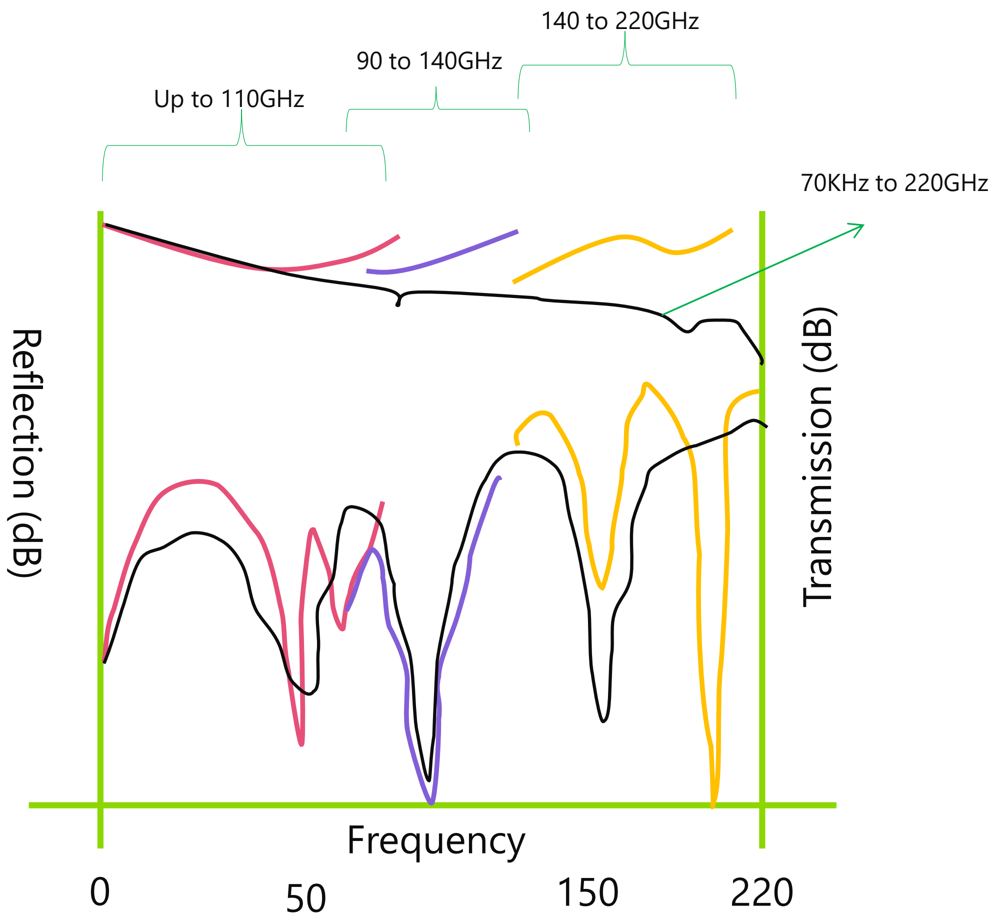




How does it work today? What are the solutions

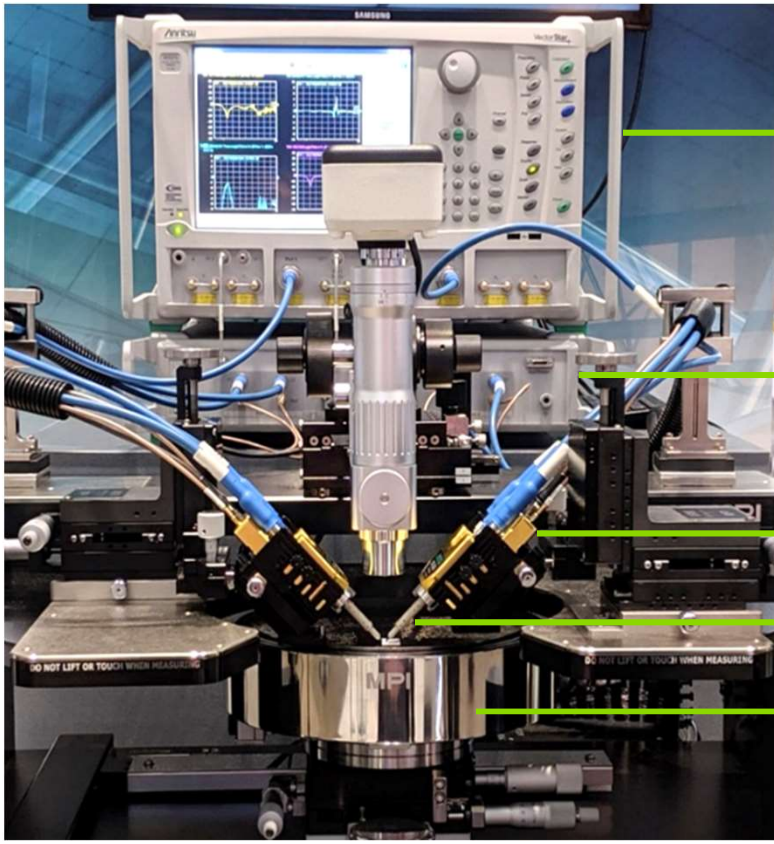
Existing solution

- Banded measurements being stitched together to see a wideband response, several challenges
  - Multiple mm-wave module setup and calibration
  - Time consuming, costly and error prone
  - Poor calibration and time stability in measurements
  - Repeated touchdowns on the device leads to repeatability issues and probability of damaging the device/ probes etc. is very high
  - Mm-wave modules are big/bulky to be setup on a probe station – physical challenges
  - Cables (co-axial) or waveguide bends are required at higher frequency to connect the probes and the mm-wave modules – leads to dynamic range reduction , magnitude and phase variations, causes stability issues and costly.



Anritsu Single sweep 70KHz to 220GHz – Single ended and differential

Anritsu ME738G – 70KHz to 220GHz



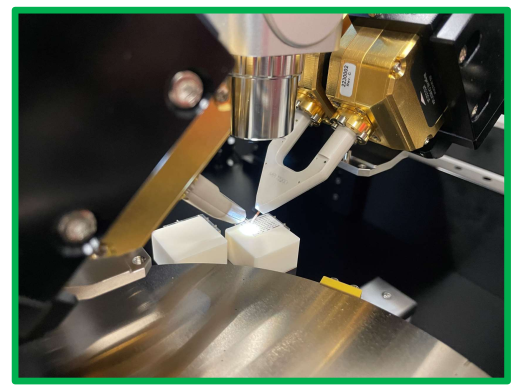
Vector Network Analyzer

Broadband Test set

Anritsu mm-wave modules

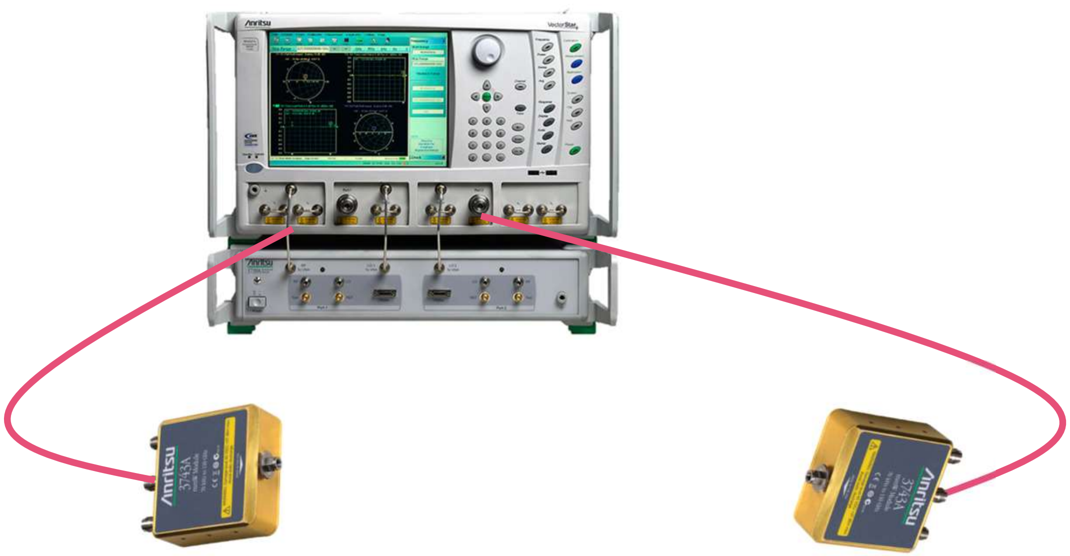
220GHz probes

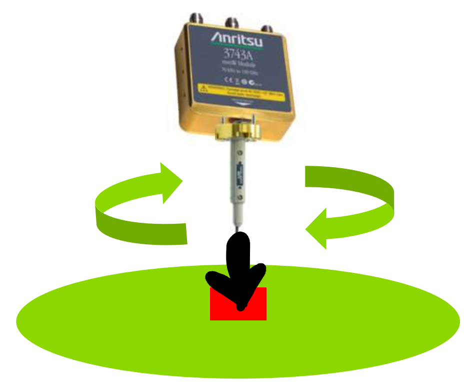
Probe station



Antenna measurements at extreme high frequency ranges

- AoC - Antenna on chip , AiP – Antenna in package needs to be characterized.
- There are several ways by which these antenna measurements are made. In chambers (Far field measurements) and on the chip itself (NF to FF analysis).
  - In case of FF : An anechoic chamber is required and the distance between the Tx and Rx several meters
  - In case of NF to FF : near field measurements are taken and then processed for FF measurements.





Thank you

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