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DISRUPTIVE TECHNOLOGY IN RF& Some aspects of Antenna Technology
(Small Appreciation note)
(Editorial Article)

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DISRUPTIVE TECHNOLOGY

I DISRUPTION

1) Disruption or problem which interrupts an event, activity or process

2) Radical change to an existing industry, product, process or market due to technological innovations.

Needless to add here that there is a caveat as that no industry or system including agriculture are immune to digital disruptions.

A disruptive technology or disruptive innovation is an innovation that helps create a new market and value network, eventually goes on disrupt an existing system and the value network.

A business theory popularized by the famous writer and technology trend analyzer/ critic Clayton M .Christensen to describe how a new technology can effect existing technology ,particularly if it is unexpected (in last decade most of the technological innovations are almost unexpected),in his 1997 bestselling book ,The Innovator's Dilemma , separates new technology in to two categories:

1) ***Sustaining:*** Sustaining Technology relies heavily on incremental improvements to an already established technology(Biggest example are the land line telephones, facsimile(FAX),where the improvements are in trunk autodialing or push button telephone sets and FAX getting connected to printer through a computer.

2) ***Disruptive Technology:*** lacks refinement, often has performance problems because it is new, appeals to a limited audience, and may not have a proven record /immediate practical application e.g. Introduction of Pagers, First Generation mobiles and direct TV to home through Satellites. Disruptive innovations are products and services that initially are not as good as those that historically have been used by customers in mainstream markets ,and therefore can take roots only in new or less –demanding applications, amongst nontraditional customers. The following figures are outcome of two separate studies but do indicate the trends of disruptive phenomena which at some time overtakes the sustained or demanding technologies or processes in an exponential manner.

(Please refer Graph 1 in the last page of this article)

(Please refer Graph 2 in the last page of this article)

The most important and glaring example of this phenomena is the advent of mobile telephones particularly with the emergence of Steve Jobs I-Phone ,which negated all the classical principles of

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communication, design including antennas and the packaging and signal processing technologies. This is the one single outstanding, biggest, largest and important example of disruption engulfing PDA , communication, computer ,clock, calculator, secretary, camera, navigator, health monitor, financial adviser, TV, musical system, recorder, and many more application. With the introduction of AI with virtual intelligence and capabilities for projection and display will take over the market of all the bulky individual systems. The following display gives an account of the progress in mobile handsets with 1-G analog set to 2 G digital one where audio and text was possible. With the advent of 3-G and 4-G audio, data, video and many more option could be exercised. With the emergence of 5-G whole communication paradigm has changed. IOT gets the flip and of course the marketing and commercial transactions including telehealth gets big flip. **The biggest disadvantage will be the security of data and comprising of personal privacy. If one looks in to the evolution of handsets over the generations, one wonders as where are the antennas, front ends and processors. The packaging is such that if the system is opened, you almost find a monolithic module with some printed lines.**

(Please refer fig 1 in the last page of this article)

Another big disruption came in to the space technology paradigm. The conventional systems of having Geo stationary satellites for communicating, broadcasting, weather monitoring, PNT services, Middle Earth Orbit satellites for PNT services (GPS, Galileo, GAGAN, NavIC , GLONASS etc. providing GNSS services),INMARSAT providing maritime and mobile communication, low earth satellites used for surveillance, remote sensing, scientific studies etc. **have been disrupted with the emergence of Star Link satellites and similar LEO constellations**, numbering in thousands to provide communication, internet for IOT and even PNT services. These are low cost and with high technological capabilities of onboard processing, on orbit re-configurability ,satellite level redundancies, launch and replacement on demand constellation satellites. Ukraine war has shown the importance these constellations and obsolescence of the conventional satellite constellations.

4G/5G and 6-G (on the horizon) are the new examples of disruptive technology. Another technology is telehealth and robotic-remotely controlled surgeries are another examples of disruptive technologies, because it appears to threaten traditional health care and has potential to transform the industry by reducing costs, while increasing quality and patient satisfaction. IT BECAME QUITE POPULAR DURING PANDEMIC.

Microwave photonics, quantum communication, quantum internet and commuters along with hybrid quantum information networks may change the conventional respective infrastructure. MIMO Communication, MIMO Radars MIMO SAR and cognitive radars are another examples of disruption in RF domain. EM/EW weapons and use of Terra Hertz frequencies for imaging, medical applications and of course ultra-high data communications is another technology on the horizon to disrupt our technological horizons

Advent of new and miniaturized ultra-wide band antenna systems, use of frequency selective surfaces, defective ground planes, use of metamaterials, smart reconfigurable and adaptive antenna systems with frequency diversity, dielectric and dielectric resonator antennas as a part of SOC and much more are some more examples of disruption in RF domain. Their applications in smart cities, transport, your TV at home providing ubiquitous communication multimedia services along with cognitive software defined radio systems are posed to modify our life.

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II DRONES

DRONES are replacing and changing the total scenario of transportation, remote sensing, disaster management, agriculture survey and surveillance for military applications. DRONE-Constellations poised provide reliable communication with MIMO and distributed radars. One may not be surprised that self /solar cell charging UAVs and DRONES may replace fighter aircrafts, UAVs and even LEO satellite constellations for communications and broadcasting. HAPS (High Altitude Platforms) have potential to replace GEO and LEO Communication Satellites.

III RF TECHNOLOGY FOR 5-G IN THE IOT (INTERNET OF THINGS)

It will not be out of place if we acknowledge the pioneer in radio –frequency identification(RFID) technology ,Kevin Ashon, who should have coined the phrase the Internet of Things. Today the IOT has moved far beyond RFID to encompass almost any kind of ubiquitous sensors connecting the physical world to the internet. The present wave of connectivity (including 5-G) consists of a seemingly endless variety of use cases and applications, from wearable devices to smart homes. One of the biggest implementation hurdle is the number and types of competing rf connectivity standards. The key trade-off among these standards is how much data the designer needs to transmit vs. the distance to transmit- all balanced against the battery life of the system The IOT is really about services as much as things. These services need connectivity to operate> The present technology for IOT is 5-G.which will enable much faster data ,low latency for time critical services like autonomous vehicles, high capacity and band width video for cloud storage and smart cities to name a few.

The development of Si based ICs has reached a point where a large part of the front end (RF) is integrated on a single die along with miniaturized antenna and passive components. However Silicon based circuits do have limitation on the performance for the design of transmission lines, filters and radiating elements. There seems to be hope in design of future RF ICs over a chip with the use of three dimensional metal micromachining. This will enable to go in to design of milli-meter wave filters, comparable with that of waveguide technology but 1-100x smaller. The Polystrata process is a three dimensional metal micromachining process that addresses these weaknesses by providing monolithic fabrication of high performance passive circuits

IV INTERCOM TECHNOLOGY-RF DISRUPTION, IP DEVELOPMENT DRIVE EVOLUTION OF BACK –OF- HOUSE COMMUNICATION

Instead of employing multi-level transmission channels one is working in most cases with single piece of Cat-6 fiber, and an Ethernet switch connection. It does not get easier than that. IP allows production to be made anywhere. Use of air-dielectric micro coax based transmission lines provide a superior combination of low loss, high isolation and high power handling. Precision interconnects and transitions are formed monolithically to allow interfacing to traditional connectors, circuit boards and wire bonds.

Silicon based technologies, BiCMOS and SiGe are playing increasing role in designing RF circuits. There is a cost as well as integration and miniaturization advantage. Inclusion of Artificial Intelligence in Rf circuits including Antennas will make reconfigurability,I mage recognition, classification, adaptiveness and signal processing a much faster and accurate game. The new technologies on the horizon

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are Terra hertz, quantum electronics, plasmonic waveguides and quantum electrodynamics will further add to the disruptive technology paradigm.

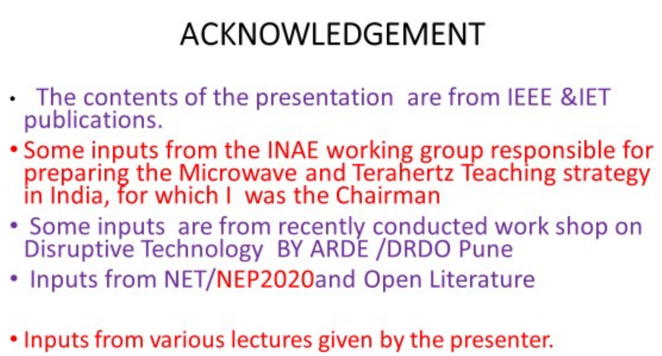
V TERRA HERTZ THE NEW HORIZON

It is a frequency band between Rf and IR, not studies seriously has a potential of several application both in communication, medical and of course detection. It is a nonionizing technology, showing properties of large interaction with matter, low tolerance to optics, extremely large band width, noise background limited signal and penetration through cloud and dust.

(Please refer fig 2 in the last page of this article)

VI 6-G AND RESEARCH OPPORTUNITIES

Not much clarity exist on the emergence of 6G communication. Perhaps it will have a peak volume of data could be 11X that of 5G.with almost zero latency, reliability of 5 nines and connectivity everywhere with better management of spectrum. Remote sensing and blind spot detection are another applications. No standards or system definition exist hence for India there is an ample opportunity to carry out research and development.



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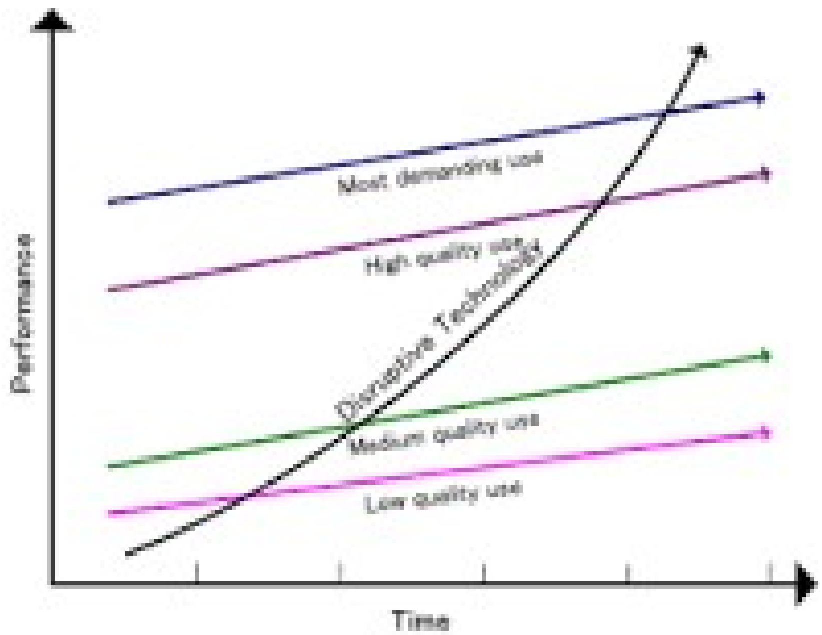
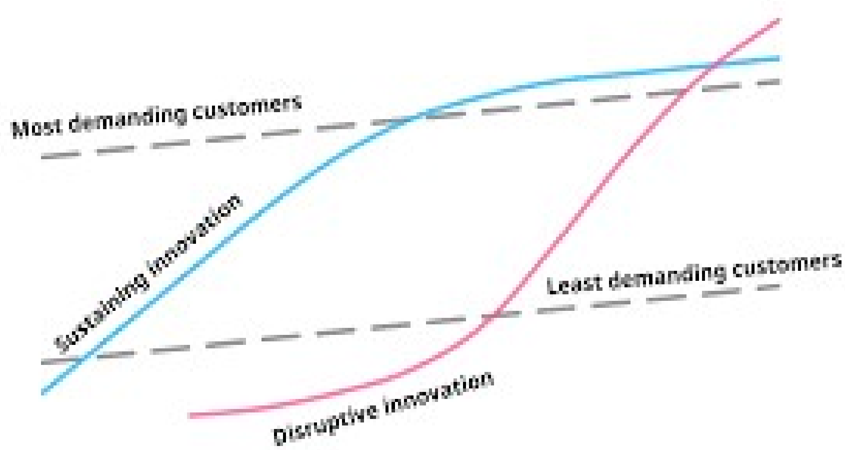


Graph 1



Graph 2

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Fig 1

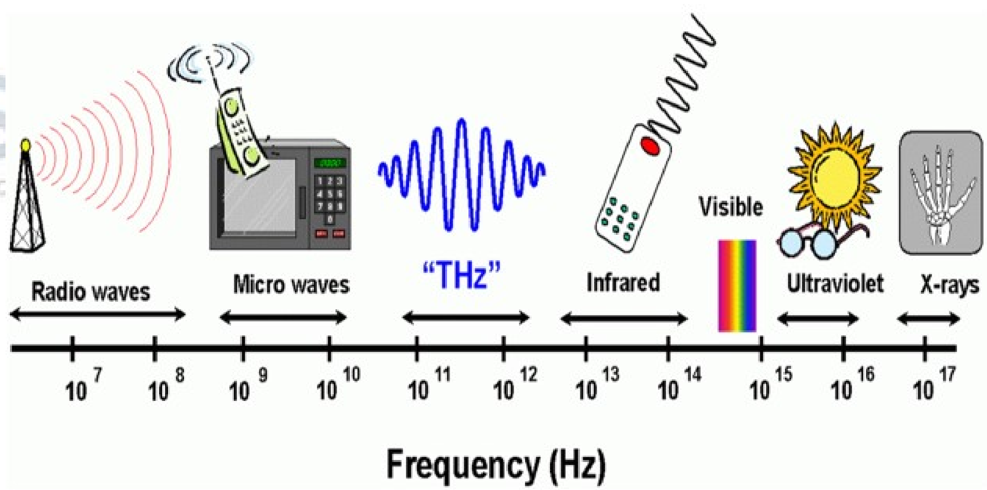

Fig 2