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TECH DEEP DIVE

TTDD 2024 CONFERENCE (7th EDITION)

REALIZING THE 6G VISION :
SOCIETAL NEEDS, USAGE SCENARIOS & TECHNOLOGIES

 **Date:** 16-19 July 2024

Concluding Day Sessions

19 July 2024

TTDD 2024 Technical Sessions Summary

S1: Usage Scenarios

Co-Chairs and Convener

Speakers



**Jishnu
Aravindakshan**



**Paventhan
Arumugam**



Vijay Madan



**Abhishek
Thakur**



R Murlidharan



Ashok Kumar



Ravi Lakhotia



**Christian
Mannweiler**



**Satish
Jamadagni**



M. Manivannan



Saurabh Mittal



Prasanta Sarkar

S2: Emerging Technology Trends

Co-Chairs and Convener



**Akshay
Aggarwal**



T R Ramya



AK Mittal

19 July 2024

Speakers



Abhijeet Masal



Chandra Murthy



**Harvish
Koorapaty**



**Jishnu
Aravindakshan**



**Johan
Johansson**



Satoshi Nagata



Saurabh Mittal



Sendil Devar

S3: Ubiquitous Intelligence: AI/ML enabled Future Networks

Co-Chairs and Convener



Brejesh Lall



**Radhakrishna
Ganti**



Vishnu Ram

19 July 2024

Speakers



**Arzad Alam
Kherani**



**Ramesh
Ramanathan**



B Ravindran



**Santanu
Chaudhury**



Piyush Kaul



Subhas Mondal

S4: Security & Privacy

Co-Chairs and Convener

Speakers



Amit Sethi



N Subramanian



Vijay Madan

19 July 2024



Anil Prabhakar



**Mohmedsaeed
Mombasawala**



**Anindita
Banerjee**



Prashant Chugh



**Debabrata
Nayak**



Sanjeev Dhallam



Hemant Rath



Vipin Rathi



**Manikantan
Srinivasan**

S5: Spectrum Aspects for 5G Advanced and 6G

Co-Chairs and Convener



Ashwani Kumar



**Vinay
Shrivastava**



AK Mittal

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Speakers



Ashok Tiwari



Debarati Sen



Diwakar Sharma



**Luciana
Camargos**



PSM Tripathi



**Sandeep
Sharma**



Sidharth Shukla



**Srinivasan
Selvaganapathy**

S6: Rural Broadband Technology Landscape

Co-Chairs and Convener



**Abhishek
Thakur**



**Sandeep
Agrawal**



19 July 2024 **Rajesh Kapoor**

Speakers



Amitava Ghosh



Kumar Satyam



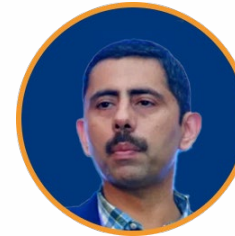
M.V Ravibabu



Prashant Maru



Sharad Arora



Vivek Dua

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Session 1 Summary on Usage Scenarios

by

Paventhan Arumugam, Education and Research Network of India



Paventhan Arumugam
Education and Research
Network of India

Dr Paventhan Arumugam is Director (R&D) with ERNET India (autonomous society under the Ministry of Electronics and IT). At ERNET, he has handled R&D projects in various domains, including the Internet of Things, EU funded MyFIRE Future Internet, Educational Cloud, Visible Light Communications, Tactile Internet, QKD Network Security.

Before joining ERNET, Dr Paventhan held several scientific and research positions at notable institutions such as the National Informatics Centre (HQ), New Delhi, C-DAC in Bangalore and the Rutherford Appleton Laboratory (RAL) in Oxford, UK.

He is a Senior Member of IEEE, a member of Internet Society (ISOC) and a Senior Member of ACM. His current research interests focus on protocols and standards for IoT, Cloud Computing, Quantum Communications and Software-Defined Networking.

Dr. Paventhan received his M.Tech in Computer Applications from IIT Delhi and his Ph.D in Computer Engineering from the University of Southampton, UK where he was awarded a research scholarship within the School of Engineering Sciences.

Session 1 consisted of two panel discussions. The first panel was co-chaired by Jishnu from Tejas Networks and deliberated on the 6G usage scenarios and the dependent KPIs. The second panel was co-chaired by Paventhan from ERNET and deliberated with 6G vertical industry on likely use cases of 6G in vertical industry.

The panel 1 deliberated with operators on the current status of 5G usage scenario deployment. All three operators concurred on eMBB as a key usage scenario. Saurabh from Airtel also indicted some initial trial and success of NB-IOT based mMTC. RedCap trial are being undertaken by Airtel. Satish from Jio believes 5G eMBB though widely deployed is not successful enough. Ravi from Vi mentioned that 5G eMBB trials is progressing well. Ashok from DOT mentioned that the rollout of 5G was very successful in India and not all rural areas are covered by eMBB.

For the 6G usage Scenario, discussion on KPI around peak data rate started with Ashok saying 20Gbps peak throughput was never achieved in actual deployment. User experienced data rate is an important KPI. Saurabh and Ravi mentioned peak data rate will be driven by new use cases which are not seen as on date. Latency as KPI for driving XR use cases is needed but lot of that will be on how latency reduction happen beyond radio layer. Uu latency is not a big concern. Interoperability and flexibility of network as a qualitative KPI was highlighted by Satish and Saurabh. Both believed this is the key KPI

along with energy efficiency.

Moving to New usage scenario everyone was keen on sensing. Operators believed that AI for network and network for AI is equally important. Ubiquitous Connectivity usage scenario and coverage as KPI was highlighted by Ashok as a key aspect which is important especially in Rural India.

The panel 2 on 6G verticals started with a presentation by Dr.Christian Mannweiler, head of the Network Architecture & Research Department at Nokia, Munich, Germany. His presentation has set the context for the panel giving the overview of 6G network evolution, brief on European Hexa-X-II 6G flagship project highlighting the migration from performance to value oriented design paradigm and covering multiple use cases possible with 6G.

It was followed by expert panellist presenting on specific verticals.

Mr R. Muralidharan, CTO, Tata Advanced Systems presented the defence vertical. He has highlighted that the global military communications market is \$35 Billion and it is growing at a CAGR of 7 to 8%. Further, he also discussed how B5G/6G is a unifying technology that brings in interoperability and transformation in military communications in a network centric connected battlefield enabled through SDR with waveforms, enhanced security and jam resistance etc. resulting in seamless communications between Space, Air, Ground and Sea.

Dr Abhishek Thakur, faculty with IDRBT discussed on 6G FinTech vertical covering aspects relating to enterprise like security, governance, multi-MNO and retail like privacy preserving data flows, phygital services etc.

Mr Prasanta Sarkar, Head – Cognitive Systems, Tata Motors presented the 6G automotive use case covering the concept of Ambupods, 5G connected ambulance sending real-time AR/VR enabled patient health data and V2X applications.

Prof. Manivannan, IIT Madras discussed on 6G healthcare vertical covering aspects on AI/ML, real-time monitoring / analytics, integration of multi-OMICS data, AR/VR/MR and Telemedicine with Haptics, mHealth and metaverse applications.

The expert panel shared their views during the Q&A session specifically focussing on how emerging 6G usage scenarios like immersive communication, hyper reliable low latency communication, integrated sensing communication etc. will impact each vertical, namely, health, fintech, defence and automotive.

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Session 2 Summary on Emerging Technology Trends

by

T R Ramya, CEWiT



TR Ramya
CEWiT

T R Ramya completed her MS and Ph.D from IITM during 2002 and 2010 respectively, both in wireless communication systems. She has about 15 years of experience encompassing academia, research and industry. She has formerly worked as a research associate in HP-IITM R&D labs, Lead Engineer in Tata Elxsi. Currently she is a Principal Research Engineer in CEWiT, focusing on issues related to 5G and also studying the work scope related to 6G. Her research interests lie in integrated sensing and communications and ambient IOT devices.

Motivation and highlights

- Motivation is to look at the new technologies or advancements to existing technologies required to enable deployment of relevant use cases and achieve the required KPIs.
- In order to throw light on the emerging technologies, three keynotes were planned
- Panel discussion following the keynote was aimed to bring out the ways and means to make the emerging technologies, a reality

Keynote Speech 1

Nuts and Bolts of 6G Communication by Johan Johannson of Media Tek

- The keynote provided a combined view from customer and operator aspects
- The shortcomings of 5G were discussed
- Cross layer approaches to achieve low latency were interestingly brought out to achieve XR requirements
- Methods to improve coverage and challenges associated with NTN-TN integration were discussed in detail
- It was emphasized how AI-prediction could help mobility scenarios achieve higher coverage with seamless handover
- Need for sustainable solutions and criteria for good energy efficiency were defined.

Keynote Speech 2

Beyond 5G communications: key technologies by Prof. Chandra R Murthy of IISC

- The talk covered the research outcomes on the much needed technologies for future cellular systems
- It was very clearly shown the cell Free MIMO + dynamic TDD can be equivalent to a full duplex system
- The need for advance receiver design to cater to massive MIMO systems was brought out
- A technique called “Irregular Repetition Slotted Aloha” was shown to be useful for massive Machine type communications
- Use of opportunistic user scheduling in Intelligent Reflecting surfaces was explained
- Need for new waveforms to cater to varying demands was also highlighted

Keynote Speech 3

Technology Enablers for 6G by Dr. Havish Koorapaty of Ericsson

- The talk threw light on energy efficiency and need to have different signals for idle and connected modes
- There was a detailed discussion on Integrated Sensing and Communications that had a valuable note that “appropriate use cases need to be looked into” for proper sensing performance
- Distributed MIMO was presented as an important enabler for 6G
- Role of AI including the need for AI HW, in improving the physical layer was emphasized

Panel Discussion

Role of key eco-system partners for successful development and deployment of 6G Technology

- Panel discussion was moderated by Dr. Sendil Kumar of Ericsson and had a good mix of panelists from industry, academia, research and operators
- The learnings made in 5G and the important future technologies were brought out from the operator's perspective
- Industry emphasized on how the learnings from 4G and 5G would be put forth for making 6G better
- Academia suggested that there should be industry indulgence in academic research to provide inputs on what is needed and what is practical etc.
- The role of research institutes to form a bridge between industry and academics was also emphasized

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Session 3 Summary on Ubiquitous Intelligence: AI/ML enabled Future Networks

by

Vishnu Ram OV, TSDSI



Vishnu Ram OV
TSDSI

Vishnu, Consultant TSDSI, has hands-on experience in the field of Telecom industry for more than 27 years, developing and implementing standards, and holds many international granted patents. He an active member of NWG13 (National Working Group 13) in India and Vice Chair of ITU-T focus group on Autonomous Networks and co-convener of ITU-T Correspondence Group on datasets (cg dataset).

He holds a Masters degree in Computer Science and Engineering from Indian Institute of Technology, Delhi. His current passion includes coordinating standards initiatives, industry bodies, open source and academia, mentoring student projects and coordinating the ITU “AI/ML in 5G” Challenge across the globe. He also curates and moderates webinars under the ITU Machine learning 5G webinar series and AI for Good. Vishnu was nominated as Scientific Advisory Board Associate (SABA) member of Motorola Networks and is a senior member of IEEE.

Session started with the context setting by Prof. Brejesh Lall

Dr R Balaraman of IIT Madras delivered first keynote presentation, addressing a very interesting question about whether AI is ready for the real world. Work is required to address limitations, LLM issues, robustness and ethics of building AI.

Dr Santanu Chaudhury from IIT Delhi provided insights into how AI will be enabled by the next gen N/W, enhancing its effectiveness, impact on the tech landscape, deploying AI as a service and use cases.

A lively panel discussion ensued moderated by Prof, Radhakrishna Ganti. The discussion explored how will AI/ML benefit the next gen wireless networks. The panel featured experts from Prof. Arzad Kherani (IIT Bhilai), Dr Piyush Kaul (Qualcomm), Ramesh Ramanathan (Tata Elxsi) and Subhas Mondal (HFCL).

The session garnered positive response from audience with an engaging Q&A.

The session was co-chaired by Prof. Radhakrishna Ganti (IIT Madras) and Prof. Brejesh Lall (IIT Delhi)

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Session 4 Summary on Security & Privacy

by

Amit Sethi, TCS



Amit Sethi
TCS

Amit is an experienced strategist and specialises in Network Services domain. He leads the team focused on Industry 4.0 development over 5G Private Network.

Amit is seasoned professional with demonstrated leadership skills in Strategy, Planning, Advisory Services, Organisation capability, Customer Relationship and Managed high-performing cross-functional teams in delivering transformational initiatives. He is passionate about technology and its ability to help enterprises achieve business success.

Amit has 24 years of experience, which spans across Telecom service line Incubating, nurturing and scaling leading edge technology services.

This Session focused on Security & Privacy and we had 2 wonderful panel discussions that deliberated on two-aspects of Quantum Technologies in the context of 6G and End-to-end security. First panel brought out deeper insights with respect to the Intersection of 6G and Quantum Technologies underscoring the need to consider these from design stage itself. Panel emphasized the need to leverage Post Quantum Crypto primitives for widely used protocols in 6G such as IPSEC/TLS and linking up Quantum Key Distribution (QKD) for secure communications. Second panel deliberated in-depth on aspects of end-to-end security in 6G including network architecture, secure data handling, and addressing threats from virtualization, SDN/NFV etc. The panel also brought out the opportunities towards leveraging AI for networking intelligence, zero trust principles, and privacy-enhancing techniques across sectors.

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Session 5 Summary on Spectrum Aspects For 5G Advanced and 6G

by

Ashwani Kumar, Nokia



Ashwani Kumar
Nokia

An accomplished industry leader technology & spectrum standardization with 32 years of experience in Telecom industry, Ashwani has served Ministry of Communication as Indian Telecom Service officer (1992 Batch) in DoT, BSNL and TEC for about 15 years, before starting career with British Telecom, Ericsson, and Huawei in senior leadership roles in 2006. Joining Nokia in 2023, he is leading Spectrum and 6G Engagements, to drive a balance of market dynamics, academic research, and policy ambitions in India.

As a founding member of TSDSI, he has been on the Governing Council of TSDSI for two terms (2017-2019 from Ericsson and 2020-22 from Huawei). Played a significant role in propelling TSDSI to become an Organizational Partner (OP) of 3GPP at a very early stage.

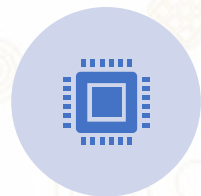
He played a lead role in global IMT spectrum standardization with significant contributions to WRC-15, WRC-19 and WRC-23 cycles. He possesses rich expertise in modelling of coex studies and conducting simulations for spectrum studies. Currently, he is driving preparatory work for WRC-27 spectrum standardization cycle in WP5D and 3GPP.

He did his B. Tech. (Electronics & Communication) and M. Tech. (Micro-Electronics), both from IIT Roorkee.

Session summary & actions forward

<p>Speaker 1 Lucina Camargos GSMA</p>	<p>Key messages –</p> <ol style="list-style-type: none"> 1. 38% global population is within MBB reach but not using 2. Strenuous negotiations cleared 6GHz band (3 R3 countries FN) 3. Additional 2GHz of mid-band required before 2030. With 700MHz in mid-band India has 1300 MHz shortfall - 6GHz critical. 4. GSMA indicates 90% indoor on mid-band, 10% on mobile (4G & 5G). 5. If FTTH demand <10Gbps, balanced alloc →1% GDP impact in 2025 6. For upto 1 Gbps of BB demand entire 6GHz band is most optimal. 	<p>Actions</p> <ol style="list-style-type: none"> 1. Conduct study to fix the usage gap 2. Accelerate policy decision for 6GHz 3. Ensure regulatory readiness of the band for assignment
<p>Speaker 2 A.K. Tiwari Rjio</p>	<p>Key messages –</p> <ol style="list-style-type: none"> 1. For 6G spectrum choice needs to be evaluated for each use case 2. 200 MHz mid-band spectrum per network needed in 2026+ for 5GA – Leverage 6GHz 3. Additional 400-600MHz mid-band spectrum per network would be needed in 2027-2030 timeframe – Maximize 7-15GHz new range 	<p>Actions</p> <ol style="list-style-type: none"> 1. Audit incumbents in 7-8.4GHz 2. Migration plan for sparse services 3. Mandate a body for CoEx studies 4. Study Indian clutter models 5. TSDSI expertise is useful
<p>Speaker 3 Siddhartha Bharti Airtel</p>	<p>Key messages –</p> <ol style="list-style-type: none"> 1. NTN is relevant to remote areas that do not have TN access 2. Natural disaster and emergencies when is TN is routed 3. Application requiring global connectivity, Ex. Maritime, Aviation 4. Device to device satellite trials conducted 5. Challenges: High delay, pathloss, Doppler shift, multiple handoff 	<p>Actions</p> <p>Study on cost aspect, viable deployment scenarios, spectrum aspects including duplexing, bands and regulations along with Device support. Device modification study needed.</p>

Summary of Panel discussion



The panel specifically felt that year-over-year data growth underscores the need for an additional 200 MHz in mid-band spectrum for XR, DT, and 5G applications.



Panelists suggested that abundant spectrum is available in low bands, while mid-bands require an additional 200-300 MHz. Bands 7.125-8.4 GHz offer opportunities for optimizing spectrum use.



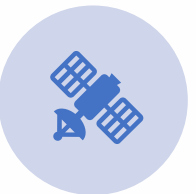
Panel recommended rapid deployment of 3GPP bands n102 and n104 in India, with issues in the 7-8 GHz band highlighting potential for regional harmonization.



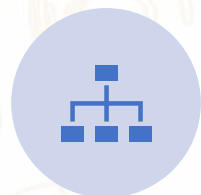
Panelists strongly recommended that satellite operations necessitate coexistence due to frequency stability constraints, emphasizing the need for context-specific studies in India.



The panel suggested that the 10-15 GHz range is currently underutilized and ideal for exploring spectrum allocation outside the ITU-R framework.



The panel specifically felt that the 7250-7900 MHz band is crucial for incumbent weather sensing, and defense satellites under FSS operation and aeronautical services, hence requiring thorough study and stakeholder collaboration for potential migration.



Panelists suggested that sub-THz spectrum is critical for JCAS, yet in early research stages.



Panelists strongly recommended that TSDSI should be used as a multi-stakeholder platform for spectrum studies.

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Session 6 Summary on Rural Broadband Technology Landscape

by

Sandeep Agrawal



Sandeep Agrawal
**Centre for Development of
Telematics**

Sandeep Agrawal is affiliated to Centre for Development of Telematics (C-DOT) India since 2008 and is working as Scientist (Team Leader). He is a Senior IEEE Member (SMIEEE) and is actively involved in the standardization of Wi-Fi & Rural Broadband technologies and contributing actively in TSDSI, IEEE and WBA. He is currently chairing IEEE SA P2872 standard to build “Interoperable and Secure Public Wi-Fi Infrastructure and architecture (ISAWANI) and IEEE SA Rural Communication Industry Connection Program. He is also the Vice Chair of recently approved IEEE standard P2061-2024 to build “Architecture for Low mobility Energy Efficient network for Affordable broadband Access”. Apart from IEEE, he is also actively involved in Wireless Broadband Alliance (WBA) as the Chair of IoT Work Group, Led of Rural Wi-Fi project and co-led of Wi-Fi sensing project.

Session was quite engaging with each of the keynote speakers talked on different aspect of Rural Digital divide

Mr Vivek Dua from BSNL talked on the BSNL Policy plan reaching out to the Rural communities by the fibre to village network, providing the end user coverage through Wi-Fi hot spots. Plan includes Smart village framework over the network covering applications of tele-medicine, Healthcare, e-commerce, OTT entertainment and smart Agriculture applications using drone. He also talked about the challenges of implementation such as business viability, skill development and cost affordability and the solution to overcome the challenges through their Bharat-net Udhmi scheme by skilling the rural communities and enabling them to maintain the rural Fibre network, create entrepreneurship and employment.

Mr Amitava Ghosh from Nokia talked on bridging the Digital divide using NTN (Non Terrestrial Network) and FMA (Fixed Mobile Access). For FMA, he delved on the representative use cases from North America and 5G/6G use cases such as multi-sensory XR (Personalized User Experience), ITS/Connected vehicles, Smart factories (Robots), Low Power Wide

Area Network (LPWAN), Digital Twins, Short Range Massive sensors (Ambient IOT). He also talked about the market growth, 3GPP future proof FMA, Performance of FMA in different frequency bands. Regarding NTN, he talked about scope of disruption that LEO, HPS based communication shall bring with their aggressive deployment, use cases such as asset tracking, agriculture, disaster recovery, defense applications etc, Cost models, partnerships and investment. He concluded with proposing NTN as the solution for overcoming Rural Digital divide.

Sharad Arora from Mashmari talked on the ways to overcome Education divide of Rural and Urban Areas. He proposed e-learning models such as Hybrid e-learning model, cloud/edge e-learning model, AI model for assessment and personalized e-learning. He also talked evidencable education for remote leaning, standardization of e-learning in ITU-T such as inclusion of definition of e-learning, remote class room, hybrid e-learning and scope of e-learning standardization in 6G.

Panel discussion has multiple questions from the moderators as well as participants.

In response to the question of **importance of last mile service providers** as seen in multiple programs such as Bharat Udyami, PMWANI (PDOs), CSC etc., Vivek Dua of BSNL highlighted their active role of these Udyami in providing the quality service as they are the first point of contact and partner in the business. They are main success of the Udyami program and differentiation what BSNL has brought into the service delivery in rural areas.

In repose to **need of affordable connectivity**, Prashant from Saankhya highlighted the ground breaking D2M technology which is built by Saankhya from ground up, completely made in India and piloted in multiple locations is able to meet the growing demand of data and able to sustain the cellular network by offloading the bandwidth intensive traffic and able to keep the cost low.

Sharad of Mashmari has highlighted the **importance of education in the rural areas**, their work of making education accessible and how connectivity is so crucial for the success. Amitava of Nokia (USA) highlighted **importance of FWA (Fixed Wireless Access) and NTN (Non-Terrestrial Network)** made available in 5G and going forward in 6G will be able to solve the ubiquitous connectivity needs and most importantly in rural areas.

Satyam of CEQU labs discussed about **the challenges in providing sustainable connectivity and their collaboration with UP government**. He highlighted requirement of funding and close collaboration with government as main ingredients for success in rural areas.

Dr. Babu of NIRD & PR talked **about how important is connectivity for perculating the impact of various digital programs and application developed by rural development ministries** to betterment of the rural livelihood. He specifically talked about geo-tagging of the rural assets.

At the end, in response of the question that “**whether India’s rural connectivity challenges are already solved by prevalent 3G/4G networks** and we need to only focus on very remote areas”, panelist responded that its not only about connectivity but what can be done using that connectivity. Though we have cellular coverage of 93%, the problem of meaningful connectivity for different sectors such as education, health etc. is far from addressed.

Thank You