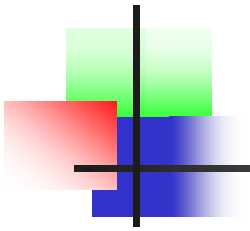


Internet of Radio Light Measurement Campaign in Building Research Establishment

by John Cosmas

Objectives

- The Internet of Radio Light has successfully conducted performance tests of a hybrid Visible Light Communications (VLC) and 40GHz mmWave 5G compliant system in the **Integer House lab** at the **Building Research Establishment**, during the months of August – October 2020.
- The objective of the trial is to measure the **coverage, latency, location accuracy and EM exposure** performance of the designed **mmWave and VLC system**, provide recommendations for improving the design and produce design guidelines for the optimal deployment of the **5G Remote Radio Light Heads (RRLHs) in buildings**.
- It thereby demonstrates how to solve the problem of **broadband wireless access in buildings** and promote 5G global standard.

Project Partners

EURESCOM

Brunel University London

VIAVI

isep École d'ingénieurs du numérique

UNIVERSITY OF LEICESTER

MostlyTek

issymedia Communication & Innovation

bre

Fraunhofer IIS

JOADA

arçelik

RunEL NGMT-Next Generation Mobile Technology

HIT מכון טכנולוגי חולון Holon Institute of Technology

ferrovial agroman

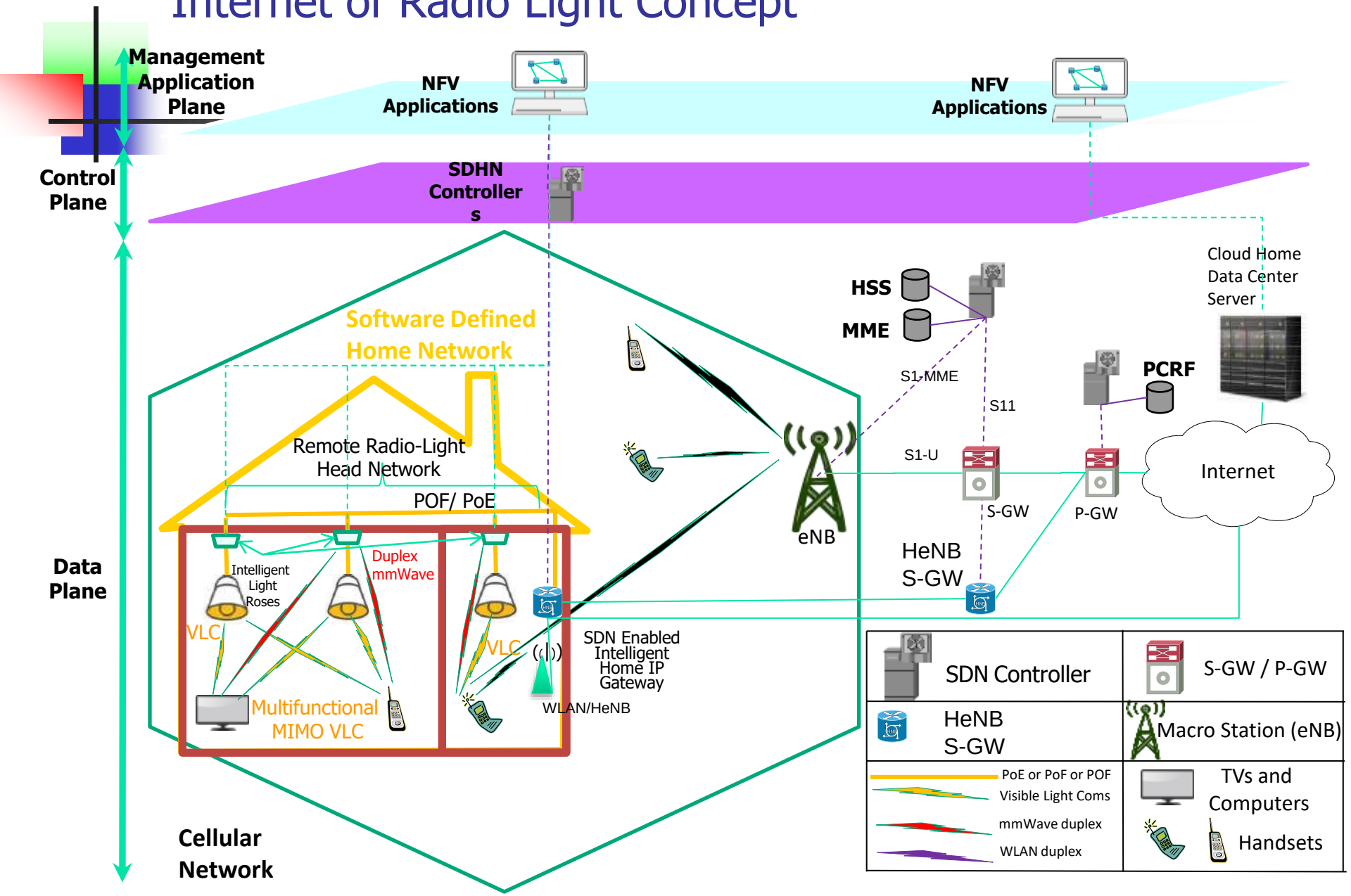
OLEDCOMM

LEADPCOM

IINESA FACS 飞乐音响

centro de innovación de infraestructuras inteligentes

Internet of Radio Light Concept



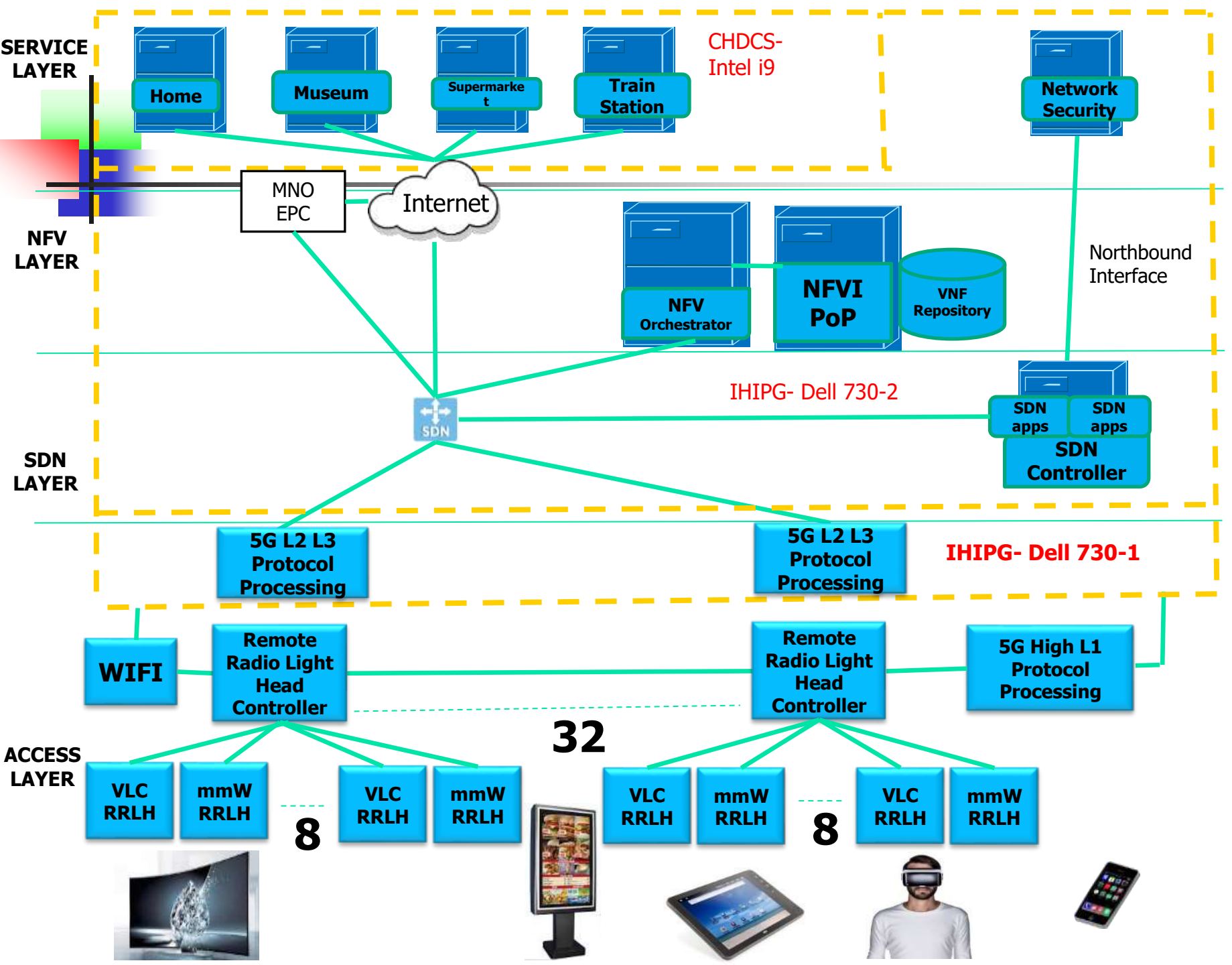
Building Research Establishment Integer House

Market Opportunity

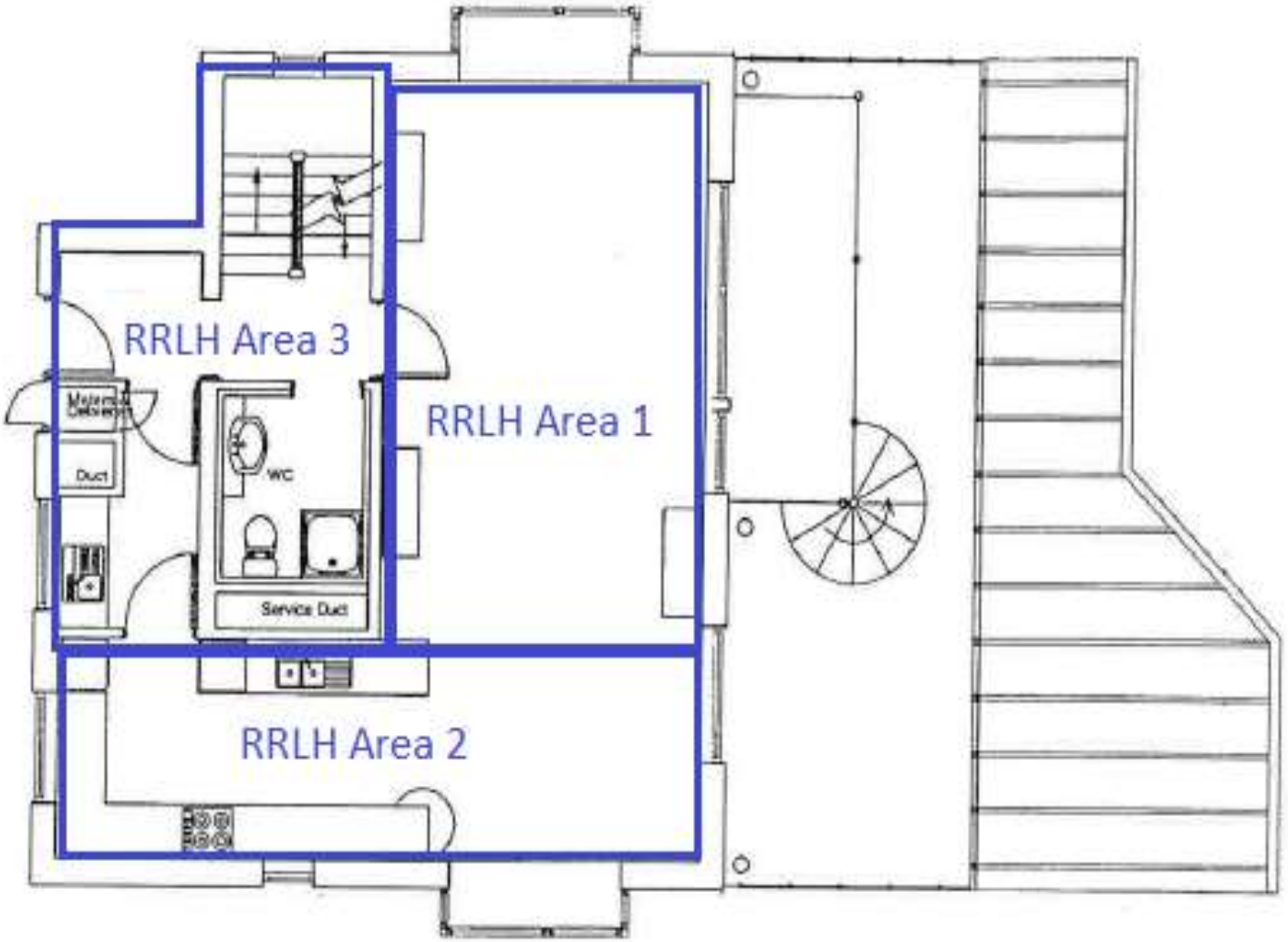
- Total number of private households within the EU-28 rose from 195 million in 2005 to 214 million by 2013
- Thus there are around 2.6 billion light access points
- 4.2 million UK home workers in 2014, amounting to 13.9% of the workforce.
- In China, there are16 national level new areas that have been designated since 2010 consisting of 16,663 Km^2 of new build urban areas.
- These new areas will be the future homes of 100 million Chinese people or approximately 30 – 40 million households with over half a billion light access points

Building Research Establishment Home

- Internet of Radio-Light Office
- AV Streaming to UHDTV
- 360^o AV Streaming to VR Headsets
- < 10cm Location accuracy of UE
- Intra Building and Inter gNB Handover
- Home Video Security Monitoring
- DoS and Rogue Tx Network Security Monitoring


SERVICE LAYER
Home
Museum
Supermarket
Train Station
CHDCS- Intel i9
Network Security
MNO EPC
Internet
NFV LAYER
NFV Orchestrator
NFVI PoP
VNF Repository
Northbound Interface
IHIPG- Dell 730-2
SDN
SDN apps
SDN apps
SDN Controller
SDN LAYER
5G L2 L3 Protocol Processing
5G L2 L3 Protocol Processing
IHIPG- Dell 730-1
WIFI
Remote Radio Light Head Controller
Remote Radio Light Head Controller
5G High L1 Protocol Processing
32
ACCESS LAYER
VLC RRLH
mmW RRLH
8
VLC RRLH
mmW RRLH
VLC RRLH
mmW RRLH
8
VLC RRLH
mmW RRLH

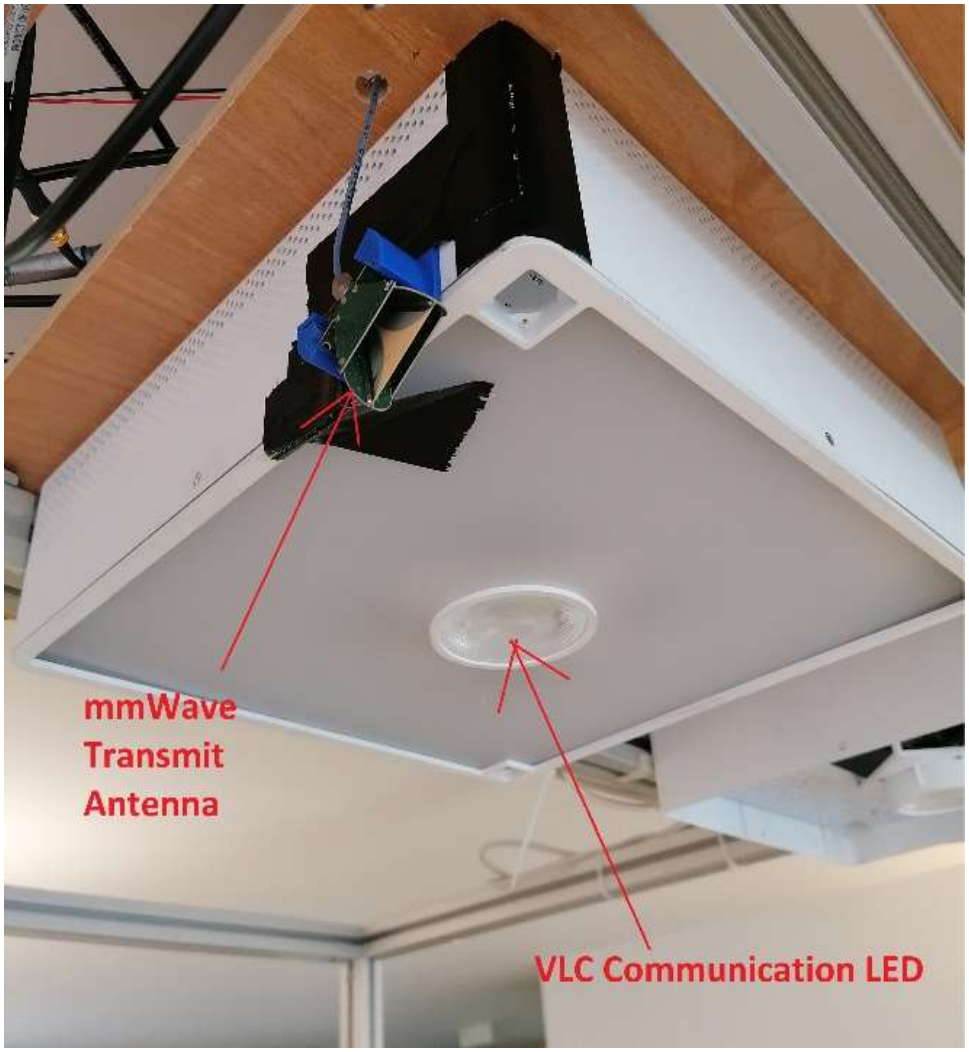
Building Research Establishment Integer House – Ground Floor Layout



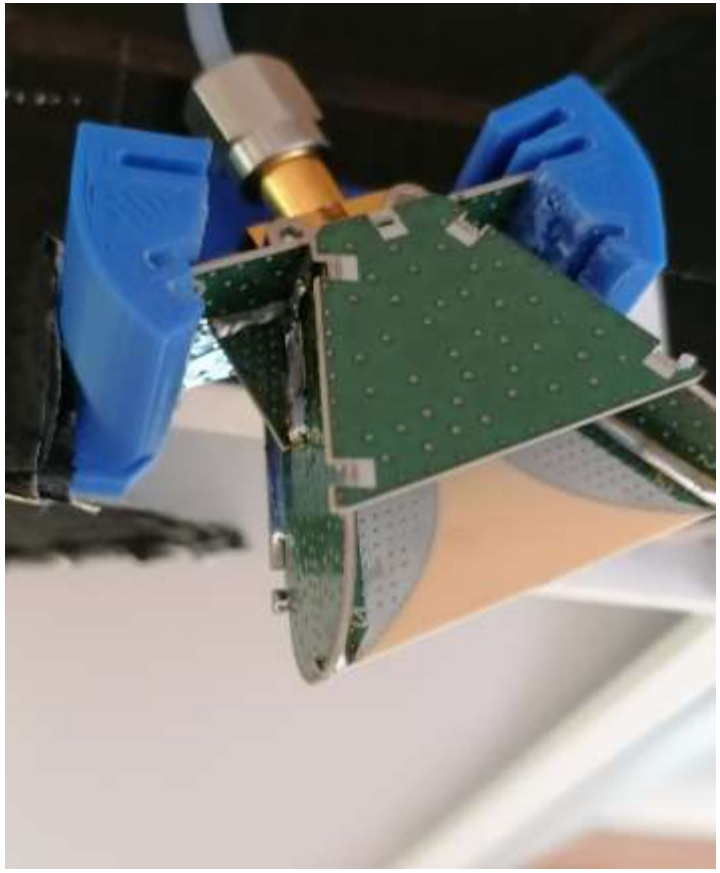
Brunel University Research Assistant taking mmWave Measurements

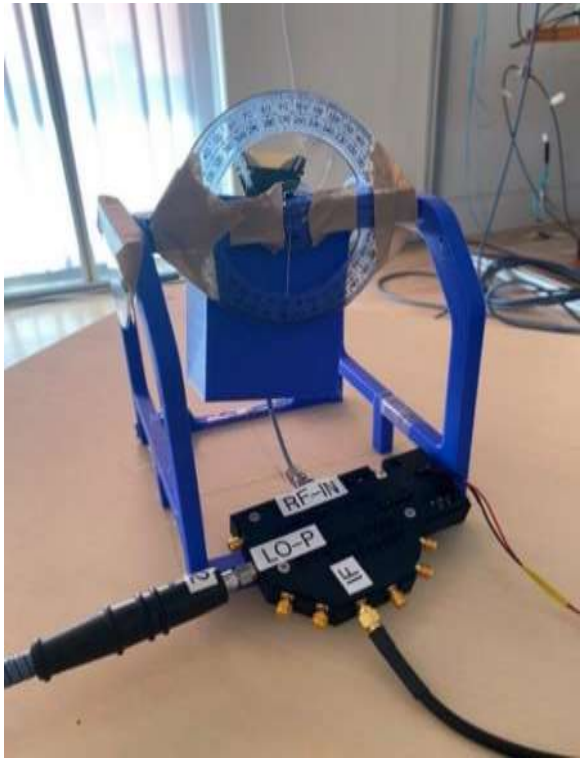
Brunel University Research Assistant taking VLC Measurements

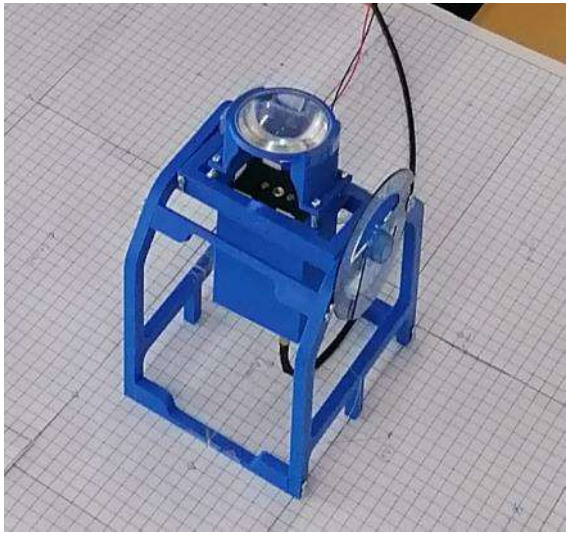
Building Research Establishment Integer House



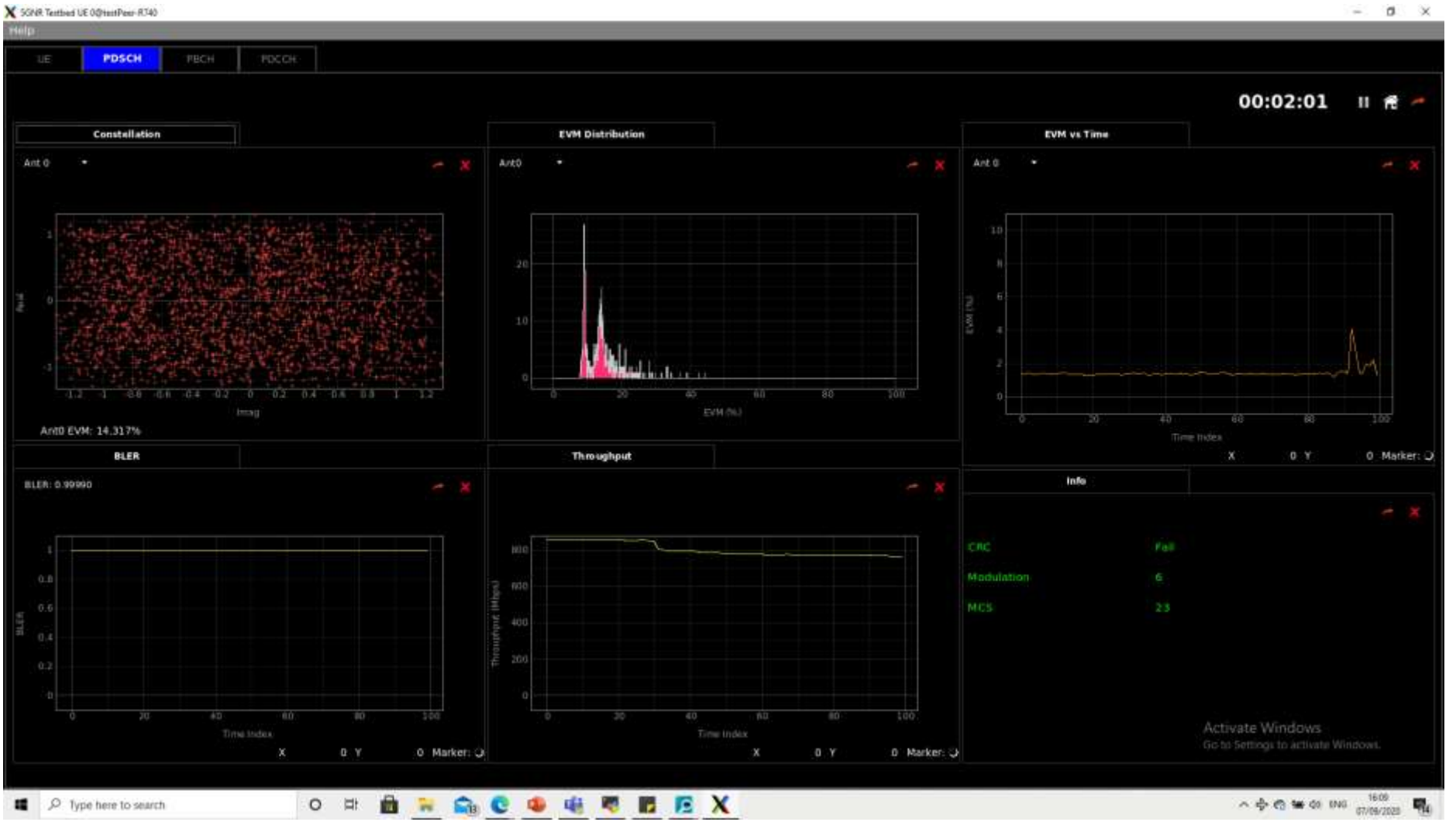
3D Printing Innovations
Angle Gimbal





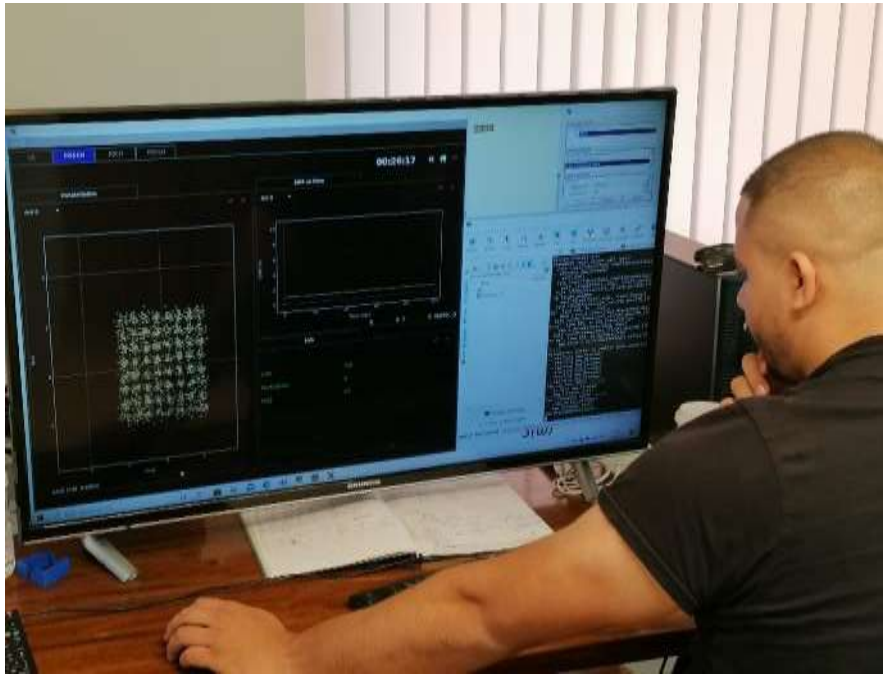


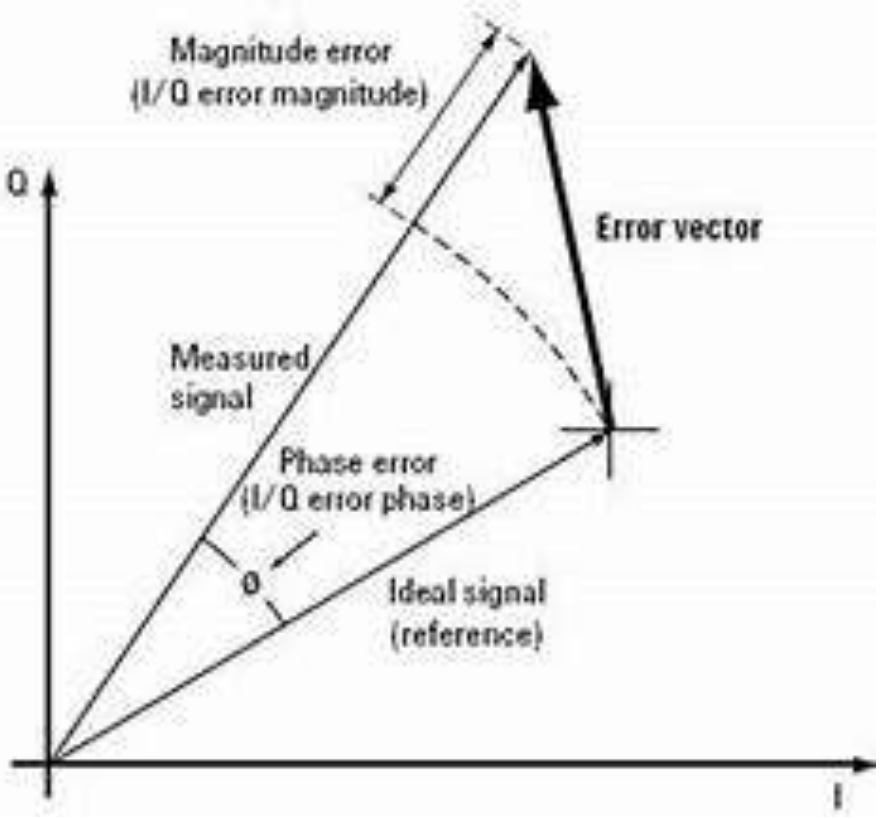
Viavi Solutions Test 5G User Terminal



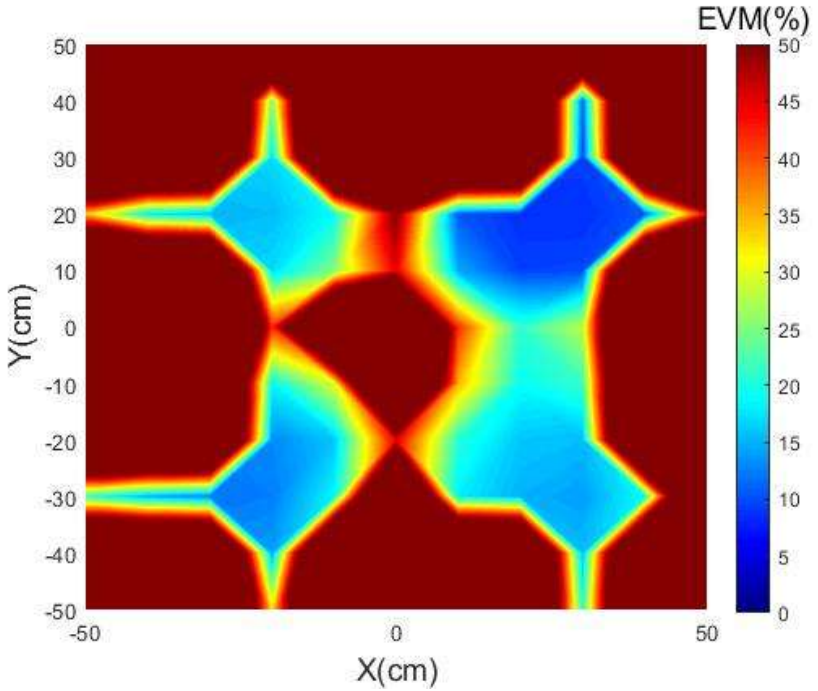
Error Vector Magnitude (EVM)

- 4-QAM requires an Average EVM < 12%
- 16-QAM requires an Average EVM < 10%
- 64-QAM requires an Average EVM < 8%

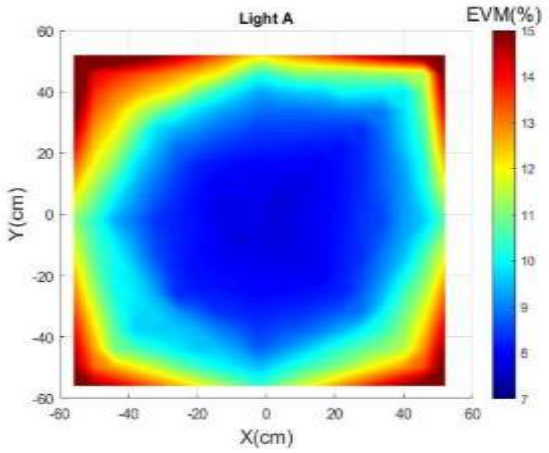


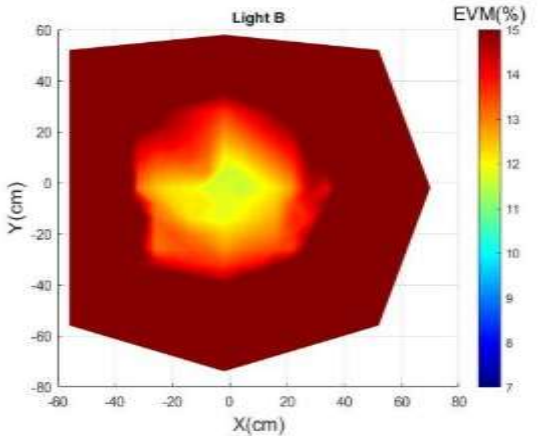


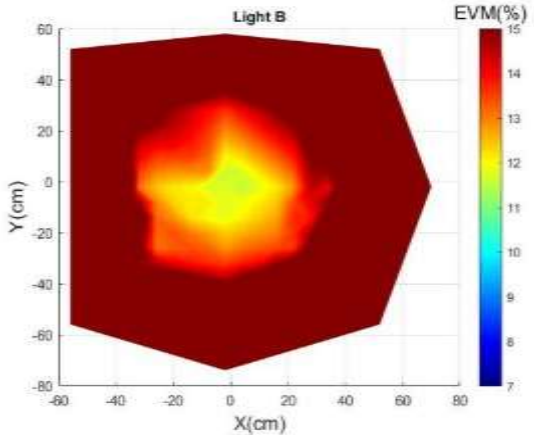
No angling of VLC Photodiode Receiver towards Communication LED

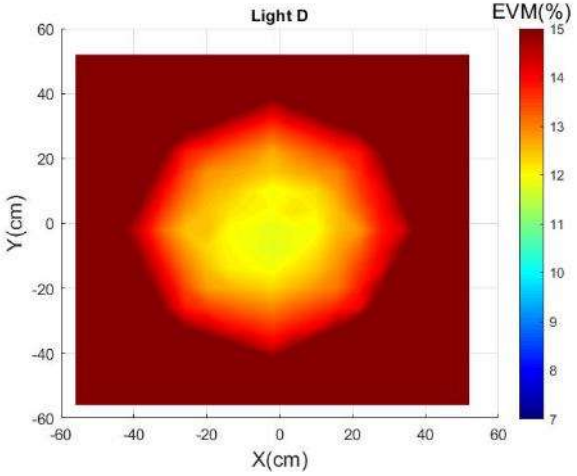


Angling of VLC Photodiode Receiver towards Communication LED



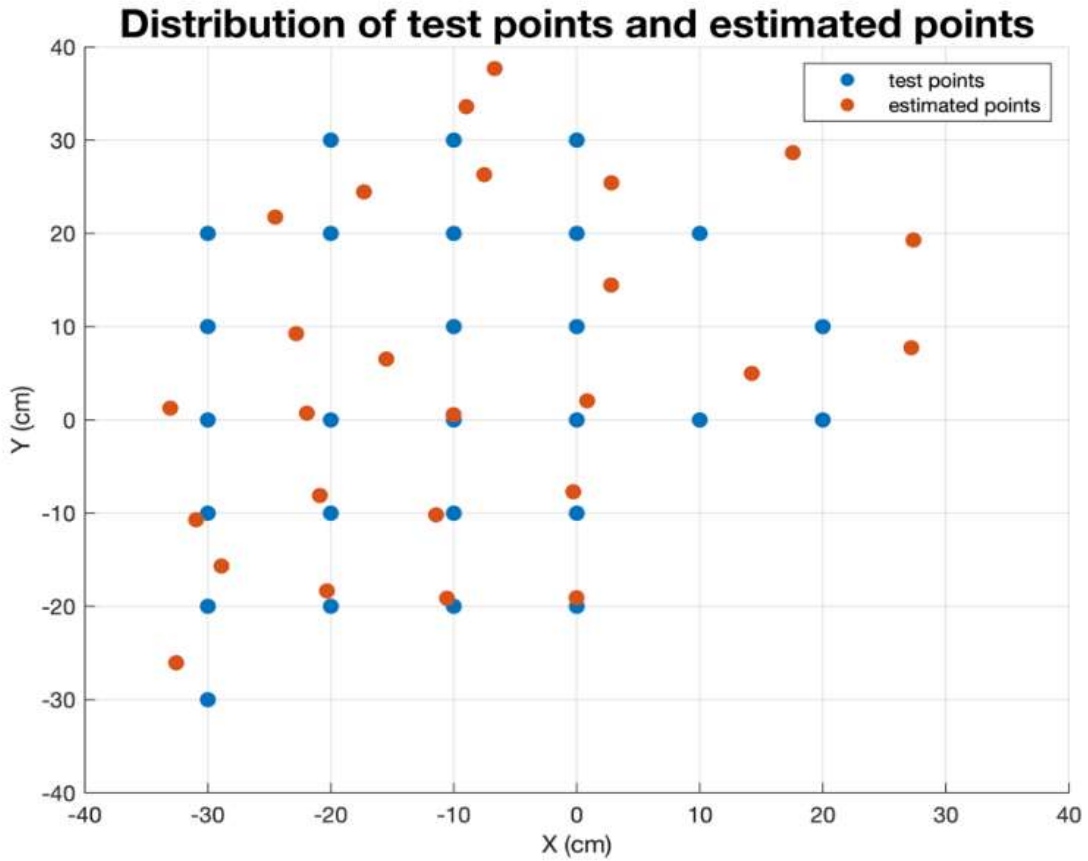




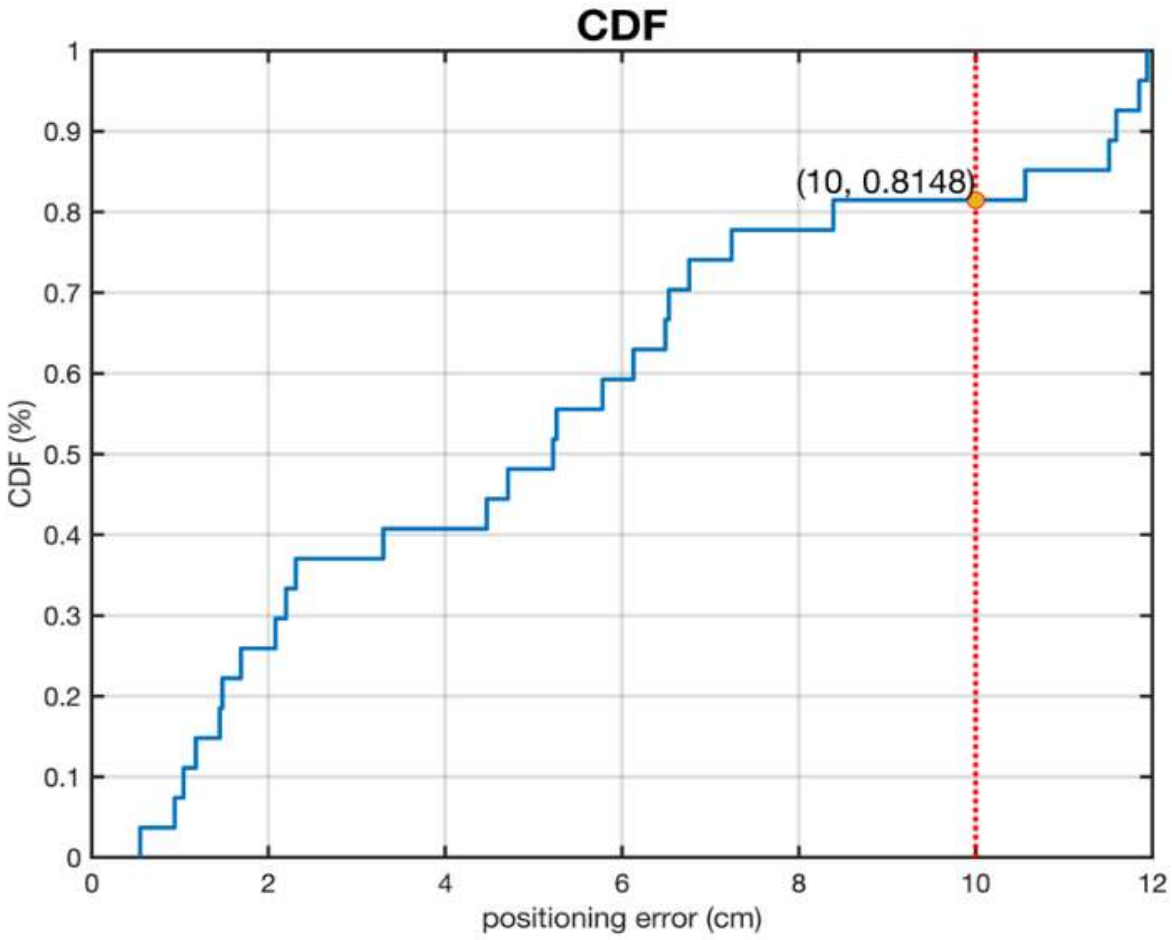


VLC Localisation Results

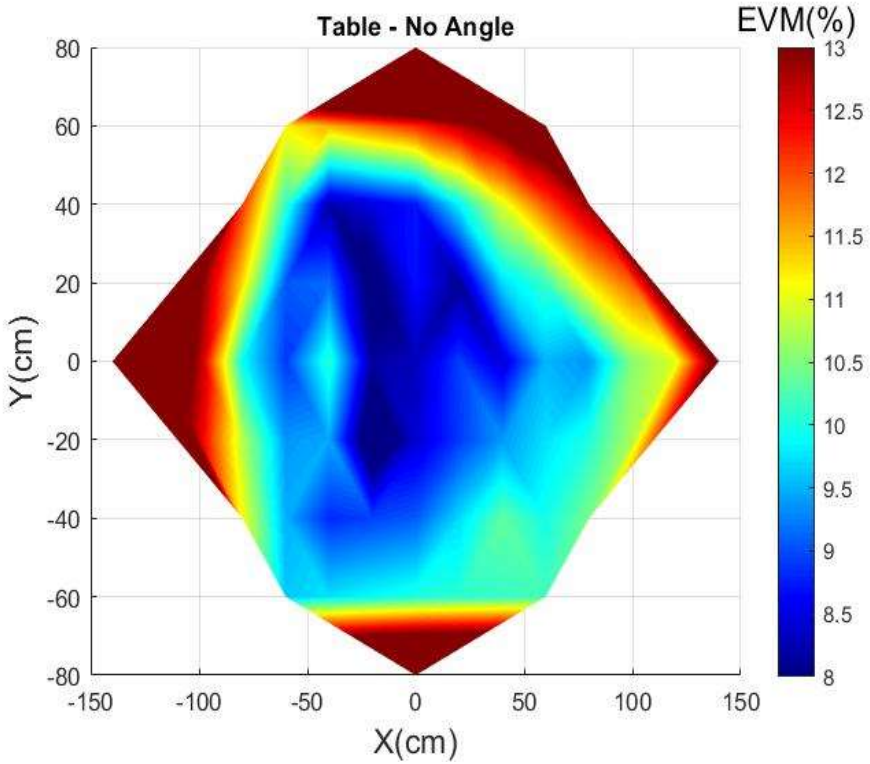
pe_min(cm)	pe_max(cm)	pe_avg(cm)
0.55	11.94	5.28

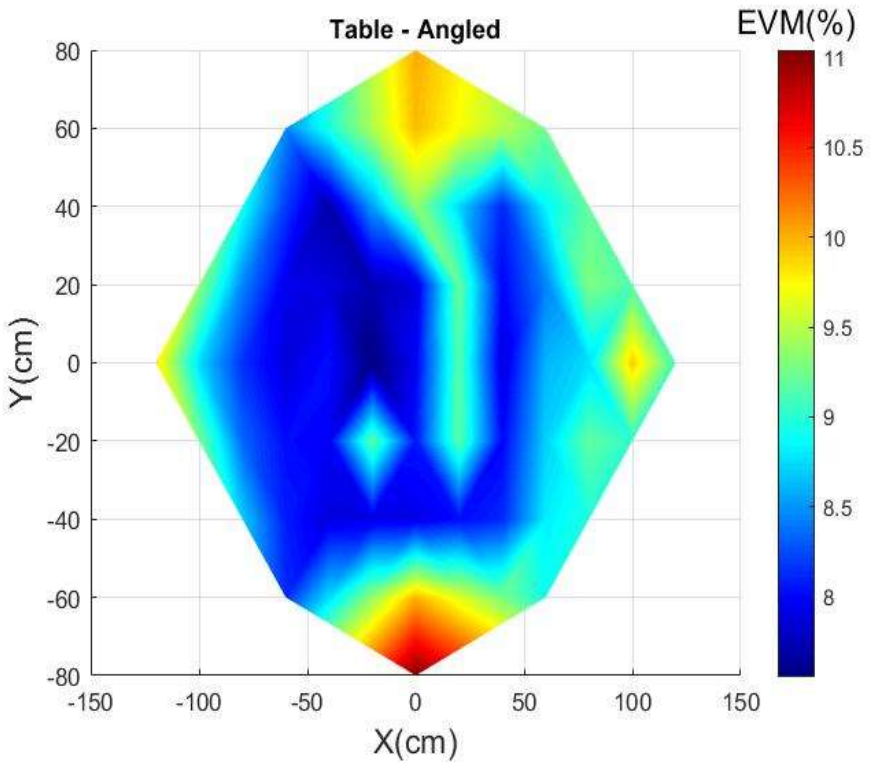


Complementary Distribution Function of VLC Localisation Error

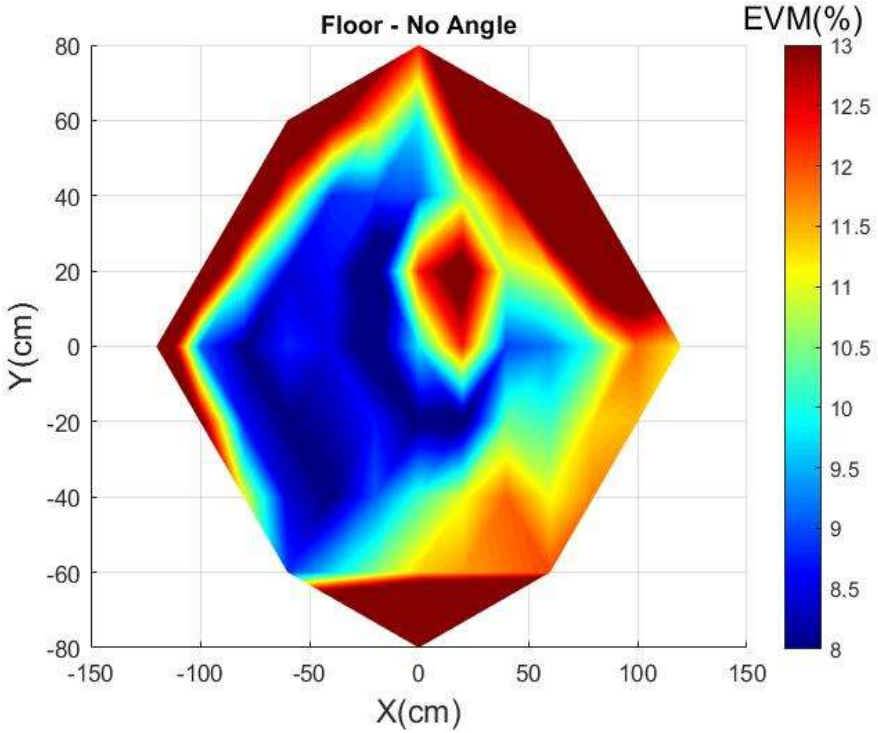


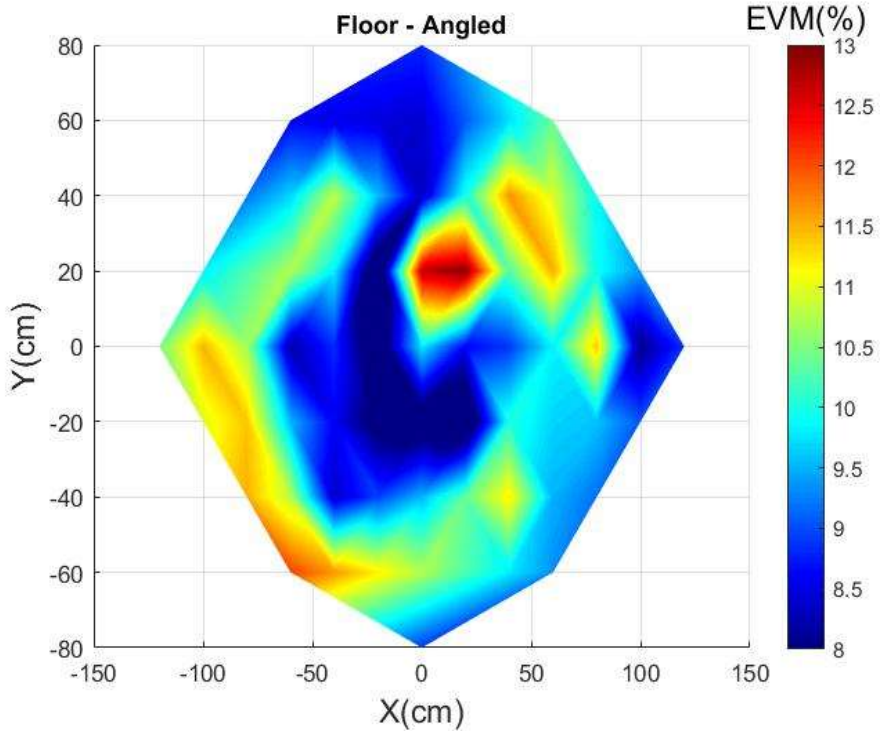
One mmWave TXs, receiver at 0.7m above ground EVM Test



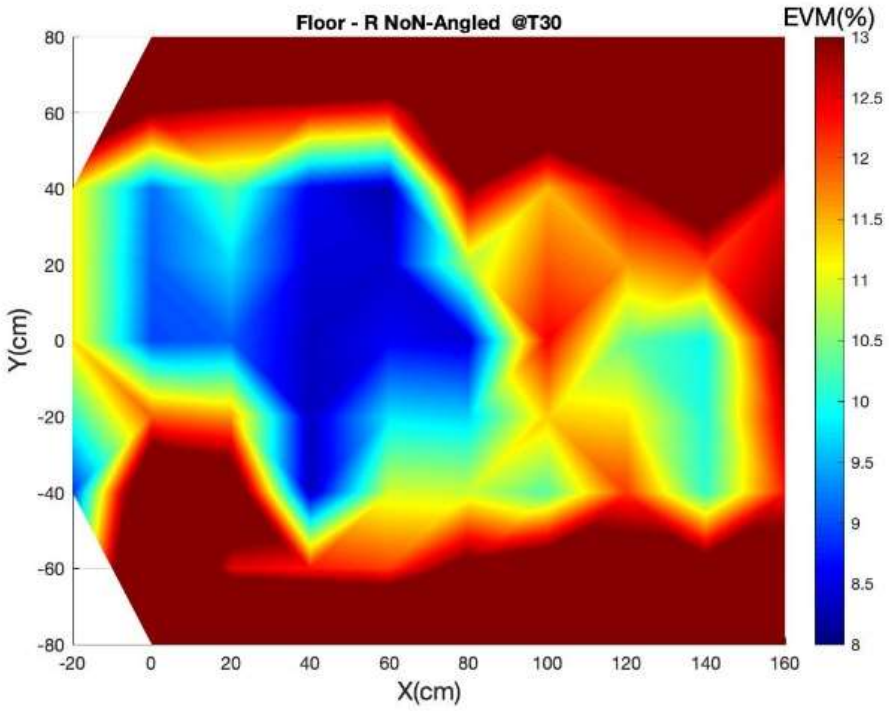


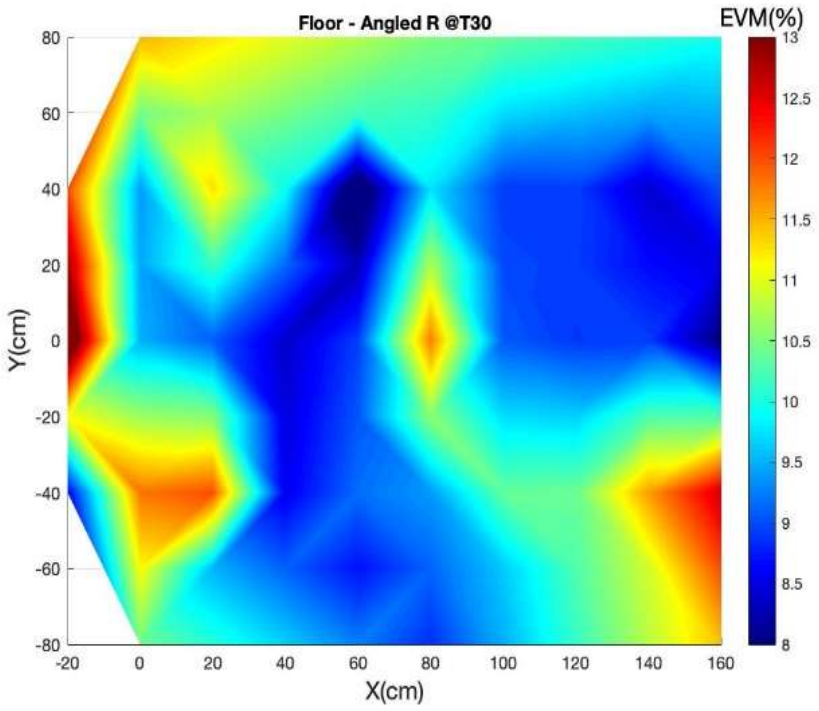
One mmWave TXs, receiver at 0m above ground EVM Test





mmWave Transmit Antenna Pointing 30° from Vertical about antenna y-axis





Key Performance Indicator mmWave & VLC Throughput, Latency

- 42 Mbps was obtained on the VLC system with 10MHz bandwidth, 4-QAM and SCS=30kHz on the Viavi testbed
- VLC Coverage area 1m x 1m per Light head – making it suitable for personal area networks
- VLC location accuracy 3.5 cm
- 310Mbps was obtained on the mmWave system with 100MHz bandwidth, 64-QAM and SCS=30kHz on the Viavi testbed.
- 70Mbps using 100MHz bandwidth with 4-QAM and SCS=30KHz at mmWave in the laboratory using the Runel testbed
- mmWave coverage area 2m x 6m
- Less 0.5ms latency has been measured at 10 MHz bandwidth at the physical layer between the UE and the DRAN.

Key Performance Indicator Potential mmWave & VLC Throughput

- RRLH Controller and DRAN designs could be enhanced to operate at 400MHz bandwidths with 64-QAM and SCS=30KHz at mmWave to produce **1240Mbps per RRLH Controller** in a final commercial FPGA/ASIC system.
- This **1240Mbps** is scalable since it can be **provided to each of up to 32 RRLH Controllers in rooms in a building** to a **total of 10Gbps** from a 10Gbps Ethernet ring home network.

Acknowledgement and disclaimer

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- This presentation reflects the author's view, only, and the Commission is not responsible for any use that may be made of the information provided.

Thank you for your attention

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