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HATHOR

Hybrid Architectures with highly energy-efficienT High-Capacity Optical/Radio Networks

- The **UEssex Access Networks Group** (ANG) has state-of-the-art mm Wave wireless and system measurement tools, including a top-of-the-range 100-GHz sampling scope, 40-GHz real-time signal analyser, 67-GHz and 90-GHz vector network analysers, with 40-Gb/s data test-set, 67-GHz synthesiser and spectrum analyser and 400-Gb/s optical sampling head. In addition, UEssex ANG has a mm-Wave probe station for mm Wave antenna radiation pattern measurement, as well as design workstations with ADS and CST software.

- Headed by Prof. Stuart Walker, the Access Networks Group is part of the large Future Networks research team within the school of Computer science and Electronic Engineering (CSEE).

- The ANG specialises in applying **wireless and optical technologies** to future **access networking** infrastructures, with **highly energy-efficient technologies** being of particular interest. More recently, the ANG has added **mm-Wave** systems- including **integrated circuits and antennas** to its design and build capabilities.

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Access Networks Group – Recent Publications

Title	Authors	Source (Journal/Conference)	Year	Type	Citations
C-RAN and Optical Fronthaul Latency in Representative Network Topologies	Dave Townend, Stuart D. Walker, Neil Parkin, Anvar Tukmanov	IEEE Open Journal of the Communications Society	2025	Journal Article	—
Cell Site Densification Using mmWave and Sub-THz Line-of-Sight Wireless Fronthaul: A Deployment Feasibility Study	Dave Townend, Stuart D. Walker, Anvar Tukmanov, Andy Sutton	IEEE Transactions on Antennas and Propagation (Vol. 72, Iss. 12)	2024	Journal Article	—
Challenges and Opportunities in Wireless Fronthaul	Dave Townend, Ryan Husbands, Stuart D. Walker, Andy Sutton	IEEE Access (Vol. 11)	2023	Journal Article	1
Toward Wireless Fronthaul for Cloud RAN Architectures	Dave Townend, Ryan Husbands, Stuart D. Walker, Adrian Sharples	2023 IEEE Wireless Communications and Networking Conf. (WCNC)	2023	Conference Paper	2
Urban Wireless Multi-hop x-Haul for Future Mobile Network Architectures	Dave Townend, Stuart D. Walker, Adrian Sharples, Andy Sutton	ICC 2022 - IEEE International Conference on Communications	2022	Conference Paper	4
Line-of-Sight Probability for Urban Microcell Network Deployments	Dave Townend, Stuart D. Walker, Adrian Sharples, Andy Sutton	2022 16th European Conf. on Antennas and Propagation (EuCAP)	2022	Conference Paper	—
A Unified Line-of-Sight Probability Model for Commercial 5G Mobile Network Deployments	Dave Townend, Stuart D. Walker, Adrian Sharples, Andy Sutton	IEEE Transactions on Antennas and Propagation (Vol. 70, Iss. 2)	2022	Journal Article	3
Urban Line-of-Sight Probability for mmWave Mobile Access and Fronthaul Transmission Hubs	Dave Townend, Stuart D. Walker, Adrian Sharples, Andy Sutton	2021 15th European Conf. on Antennas and Propagation (EuCAP)	2021	Conference Paper	5
A 3D Statistical Framework for the UK’s Mobile Network	Dave Townend, Stuart D. Walker	2020 IEEE 31st Annual Int. Symp. on Personal, Indoor and Mobile Radio Communications	2020	Conference Paper	6

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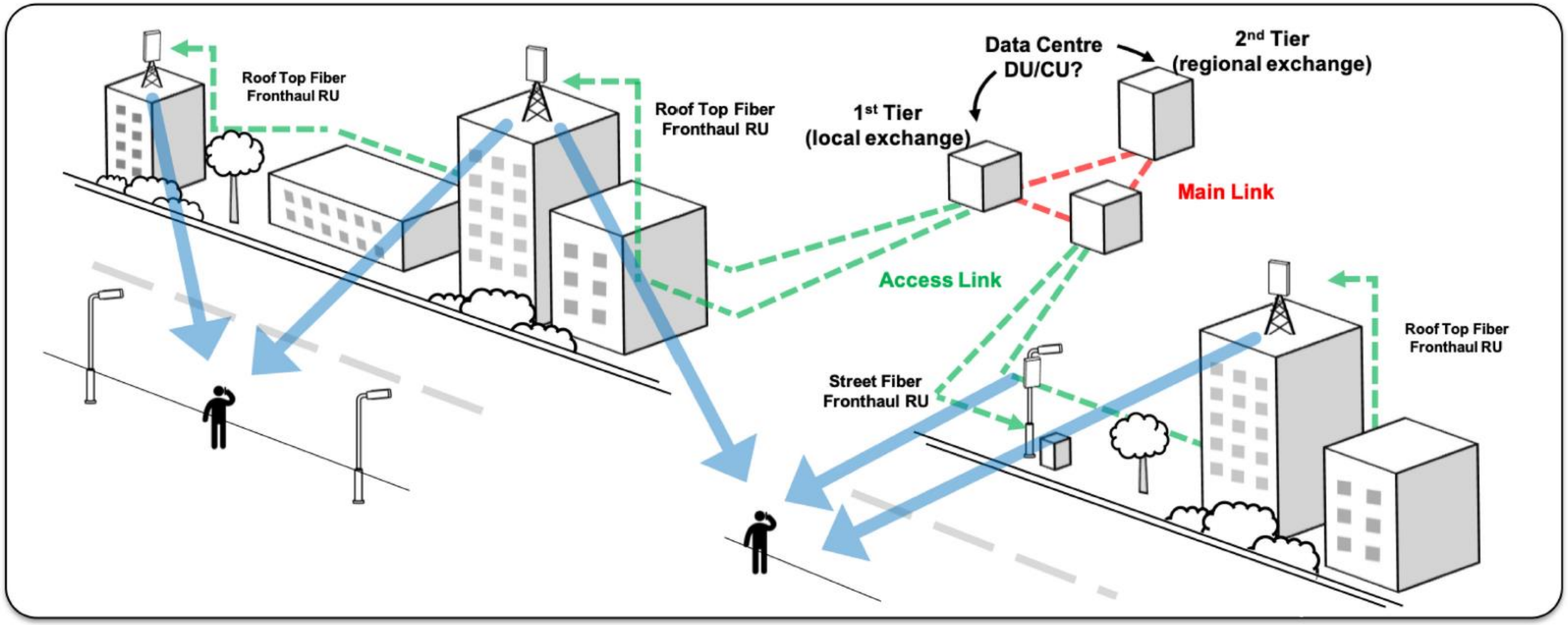
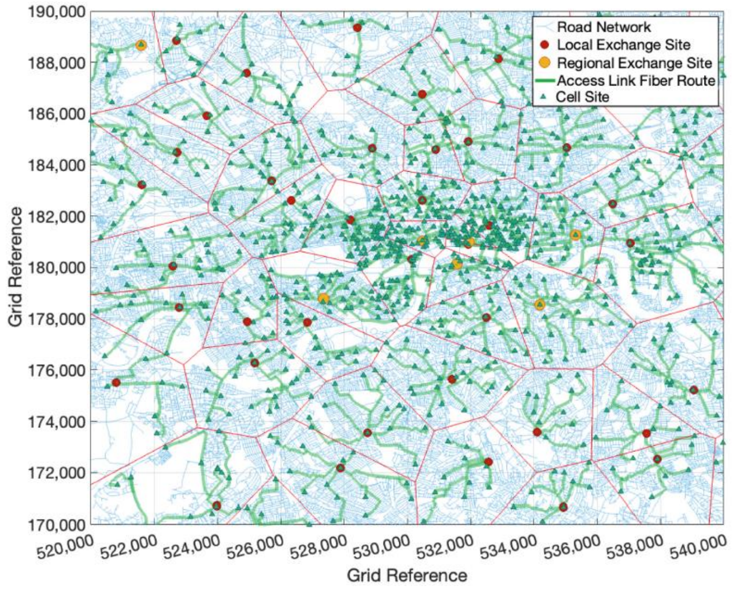
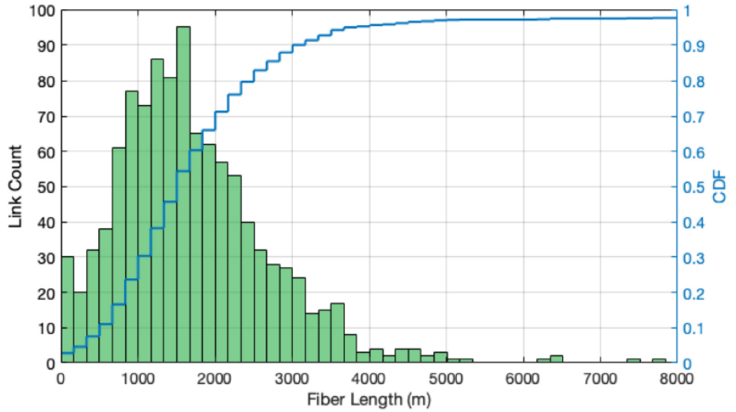
C-RAN and Optical Fronthaul Latency in Representative Network Topologies, Dave Townend;Stuart D. Walker;Neil Parkin;Anvar Tukmanov, IEEE Open Journal of the Communications Society, Year: 2025







We contribute new insights into the deployment feasibility of C-RAN based on representative fiber topologies and the associated implications to fronthaul latency. Findings have shown that a long term migration from conventional backhaul driven distributed cell sites towards a fronthaul based centralized architecture is feasible without fundamental redesign of the underlying transport network. Assuming the use of layer 2 Ethernet hops are minimized, as much as 96% of urban cell sites could be centralized to the first tier or edge estate of the network. Where larger scale centralization is envisaged as much as 91% of sites could be aggregated to regional nodes in the transport network. In addition, the deployment of HCF in fronthaul networks has been shown to significantly expand the achievable footprint of C-RAN. While HCF is not widely deployed in modern networks and any replacement of conventional SMF is likely to be costly, findings do suggest a more strategic approach to use of HCF targeting longer length main links may be sufficient to maximize the viability of C-RAN and fronthaul driven networks whilst minimizing associated cost.

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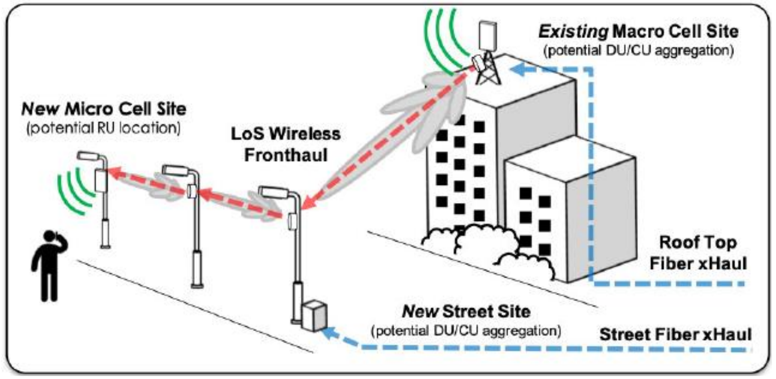
Cell Site Densification Using mmWave and Sub-THz Line-of-Sight Wireless Fronthaul: A Deployment Feasibility Study, Dave Townend;Stuart D. Walker;Anvar Tukmanov;Andy Sutton, IEEE Transactions on Antennas and Propagation, Year: 2024

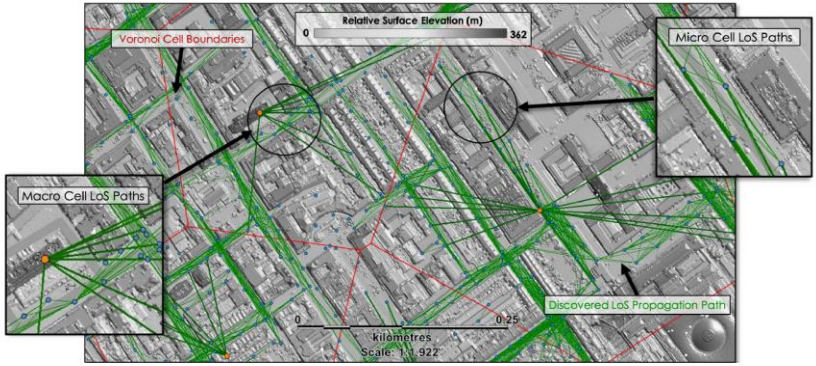
SUMMARY OF PERFORMANCE-LED DEPLOYMENT MODELING

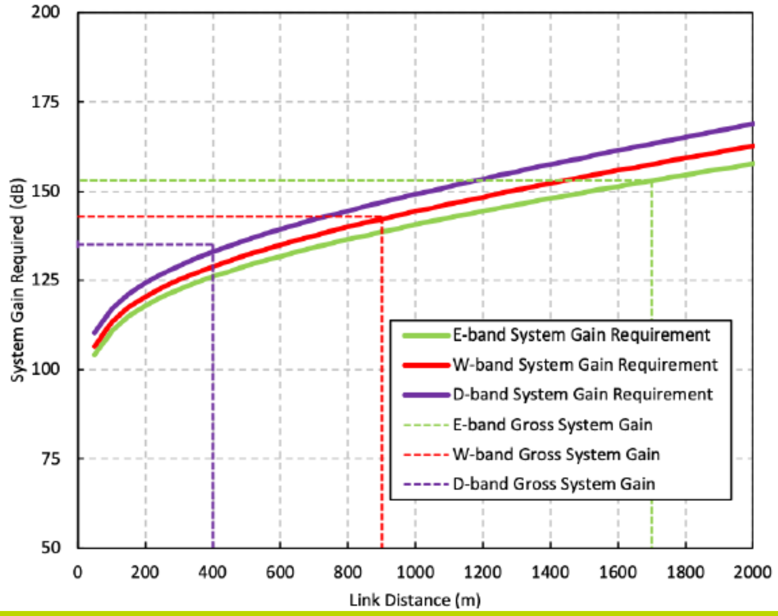
Scenario		Option 8				Option 7.2x				Option 6			
		Wireless Sites		Fibre Sites		Wireless Sites		Fibre Sites		Wireless Sites		Fibre Sites	
		Total	Hops	Total	Reason	Total	Hops	Total	Reason	Total	Hops	Total	Reason
Roof and Street Level Wireless Fronthaul Extension	D-band	11.1%	0%(1), 20%(2), 80%(3)	88.9%	100%(C)	73.3%	18%(1), 49%(2), 33%(3)	26.7%	17%(C), 83%(L)	73.3%	18%(1), 49%(2), 33%(3)	26.7%	17%(C), 83%(L)
	W-band	0.0%	-	100.0%	100%(C)	48.9%	27%(1), 73%(2)	51.1%	9%(C), 91%(L)	48.9%	27%(1), 73%(2)	51.1%	9%(C), 91%(L)
	E-band	0.0%	-	100.0%	100%(C)	48.9%	27%(1), 73%(2)	51.1%	9%(C), 91%(L)	48.9%	27%(1), 73%(2)	51.1%	9%(C), 91%(L)

Reason for fiber connectivity: (C) Capacity constrained (if wireless), (L) Latency constrained (if wireless), (J) Jitter constrained (if wireless)
■ Deployment scenario representing maximum wireless transport utilization and maximum opportunity for RAN centralisation (lowest fronthaul split).

We contribute new insights into the deployment feasibility of C-RAN-based cell site densification supported by a wireless fronthaul transport capability. The most ideal transport technology selection is assumed to be a fronthaul interface that utilizes the lowest functional split possible to maximize multicell coordination together with a spectrum band that maximizes a wireless fronthaul footprint to reduce expenditure on new urban fiber installations. Based on these high-level assumptions, findings have demonstrated that the most appropriate deployment scenario would be the exploitation of the D-band spectrum (130–174.8 GHz) and the use of an option 7.2× cell fronthaul interface to aggregate remote RUs to fiber locations. Results have shown that despite the demanding transport requirements imposed by new fronthaul interfaces, the anticipated performance of emerging wireless transport solutions operating in high mmWave and sub-THz spectrum bands, in particular, D-band, are a credible option to supporting realistic wireless fronthaul deployments in C-RAN architectures.







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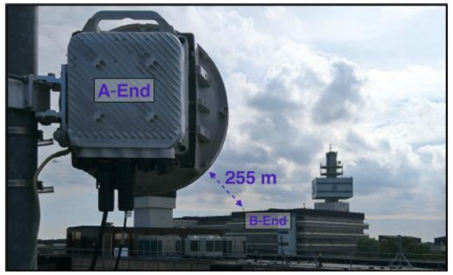
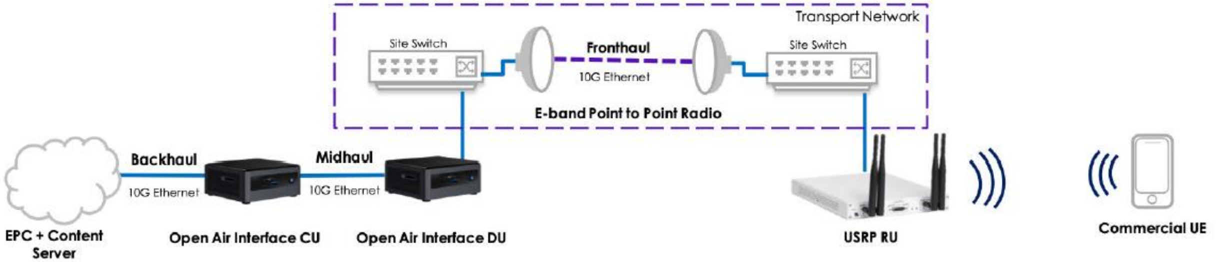
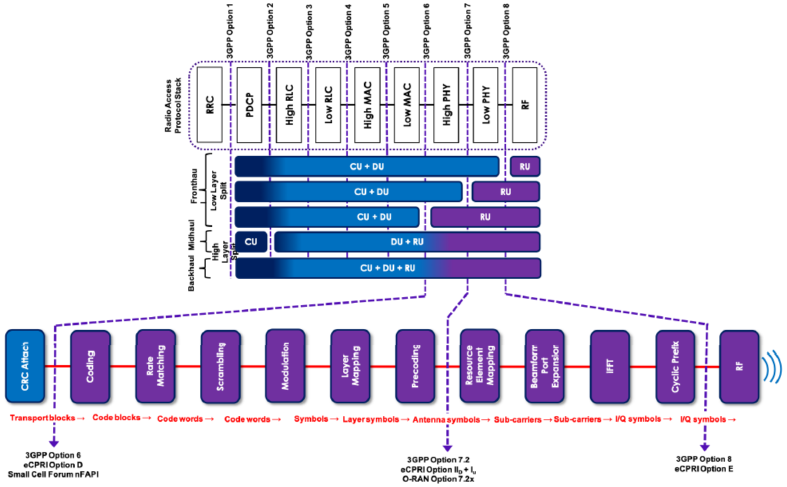
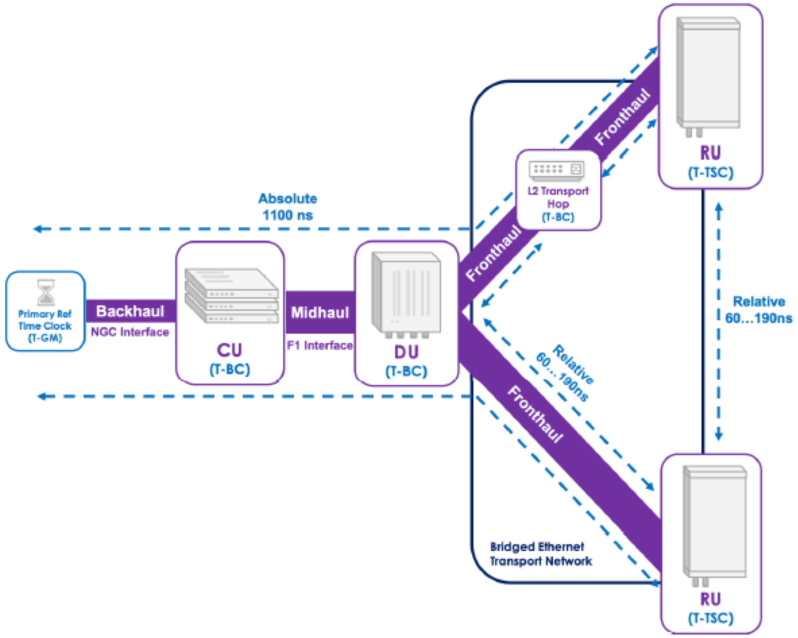
Challenges and Opportunities in Wireless Fronthaul, Dave Townend;Ryan Husbands;Stuart D. Walker;Andy Sutton, IEEE Access, Year: 2023







In this study the theoretical requirements of competing fronthaul interfaces are assessed against the performance expectations of emerging high frequency transport bands. The aim of this approach is to quantify the deployment opportunity for wireless fronthaul C-RAN deployments in the face of challenging fronthaul performance requirements generally assumed to require ubiquitous fiber transport. Finding have shown that in spite of the demanding transport requirements imposed by emerging fronthaul interfaces, the anticipated performance of wireless transport systems operating in high mmWave and sub-THz spectrum bands is capable of supporting realistic wireless fronthaul deployments. The capacity requirements for an example 5G small cell with an eCPRI option 8 fronthaul split mean this split is only realizable with large 5 GHz channel bandwidths possible in D-band and even then are only achievable with short link lengths < 100 m. Alternative splits such as O-RAN option 7.2x and SCF nFAPI option 6 show more promise and could be supported on smaller 2 GHz channel bandwidths possible with E and W band where link distances are comparable with urban inter-site distances. In addition, it is anticipated that future advancements and maturity in wireless transmission systems >100 GHz could further enhance the performance and link lengths achievable in wireless fronthaul transport networks. Advanced radio interface techniques already realized in lower frequency microwave bands including the simultaneous use of multiple carriers, higher order modulation, a second polarization or line-of-sight MIMO techniques promise to double or even quadruple the aggregate link capacities suggested in this work. As a result, it is conceivable that future wireless transport solutions >100 GHz could realistically achieve performance parity with 40 Gbps or 100 Gbps fiber optic solutions over short distances. Such capability, in addition to supporting single RU small cell deployments, could also realize larger multi-sector, multi-carrier macro cell sites. The findings of this study not only demonstrate the feasibility of the wireless fronthaul concept but highlight a real-world opportunity to evolve the distributed-RAN deployments of today, heavily dependent on lower capacity microwave backhaul, towards more centralized fronthaul orientated architectures using high capacity mmWave and sub-THz transport bands.



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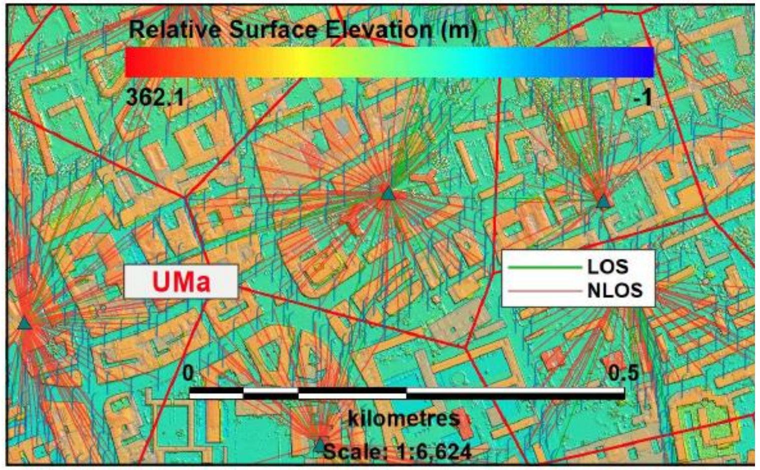
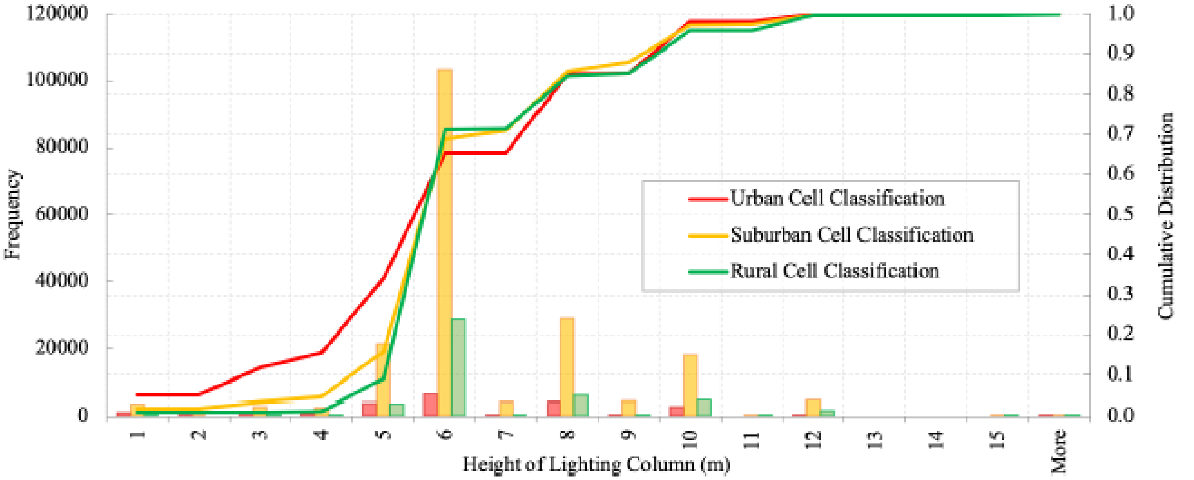
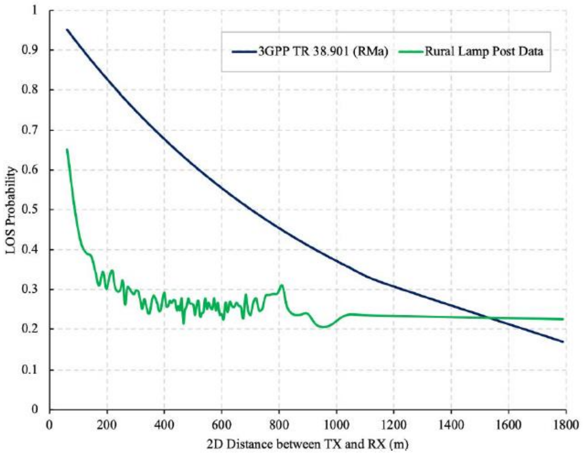
A Unified Line-of-Sight Probability Model for Commercial 5G Mobile Network Deployments, Dave Townend; Stuart D. Walker; Adrian Sharples; Andy Sutton, IEEE Transactions on Antennas and Propagation, Year: 2022







We evaluated the LOS statistical channel model using a representative 3-D environmental model of a mobile network in the U.K. Existing LOS probability models were assessed against the DSM using real lamp post and street lighting locations as representative outdoor data points distributed throughout the coverage environment of the network. Published models have been shown to be unsuitable for LOS predictions for all cell types when applied to real network topology and geographic topography. As a result, the use of existing LOS probability models is insufficient for the evaluation of use cases, such as mmWave transport solutions between existing macrosites and new street infrastructure locations, which may underpin future cell densification architectures. These findings are further supported with experimental verification of the methodology used, implying that a revised statistical model suitable for such deployments is required. By extending the study to account for the height dependence of the endpoint, a new model is proposed, which includes height attributes of the endpoint below 10 m. In addition, the newly proposed model integrates urban, suburban, and rural deployment scenarios into one common definition. The proposed “BT LOS model” demonstrates good agreement for all scenarios allowing a wide range of use cases to be analyzed at scale. The findings contribute significant insight into the fundamental propagation characteristics of real mobile networks, including large-scale parameter assignment for LOS and NLOS propagation conditions. Further work looking at the complimentary UMi LOS probability model is also under consideration as a means of assessing the potential TN footprint achievable with the application of street-level mmWave multihop and mesh wireless x-haul solutions.