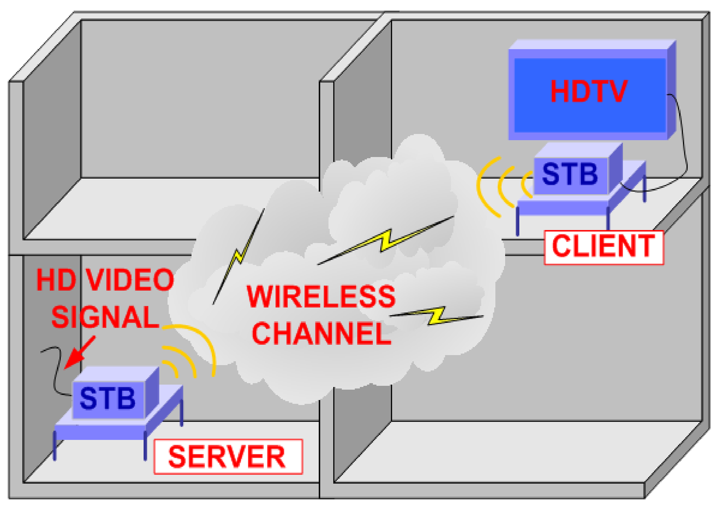
Centre for Communications Research

Optimising Radio Coverage for Wireless Media Servers

Evangelos Mellios, Geoff Hilton, Andrew Nix; Centre for Communications Research, University of Bristol. Contact – Evangelos.Mellios@bristol.ac.uk

Aim : System level analysis of the performance of a three element patch antenna array for a 2x3 802.11n wireless home media server application for High-Definition video streaming at 2.4GHz.

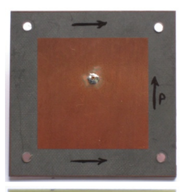
Introduction



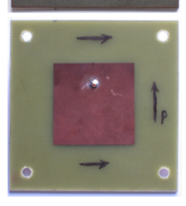
❖ With the immanent switch-off of analogue television and the recently developed IEEE 802.11n standard for WLANs, which employs multiple antennas and promises data rates up to 600Mbps, a new market is emerging for wireless home media servers; these are devices that connect to a Set-Top-Box and enable the wireless delivery of the video signal around the home.

❖ Directional patches may be chosen over the widely used in MIMO WLANs omnidirectional antennas, as with a typical position of the box being at the edge of a room the antenna beam can be used to illuminate the room.

Patch antenna substrate choice and efficiency



➢ RT/Duroid 5880 (ε_r=2.2)
Relative to a monopole measured efficiency: ~80%

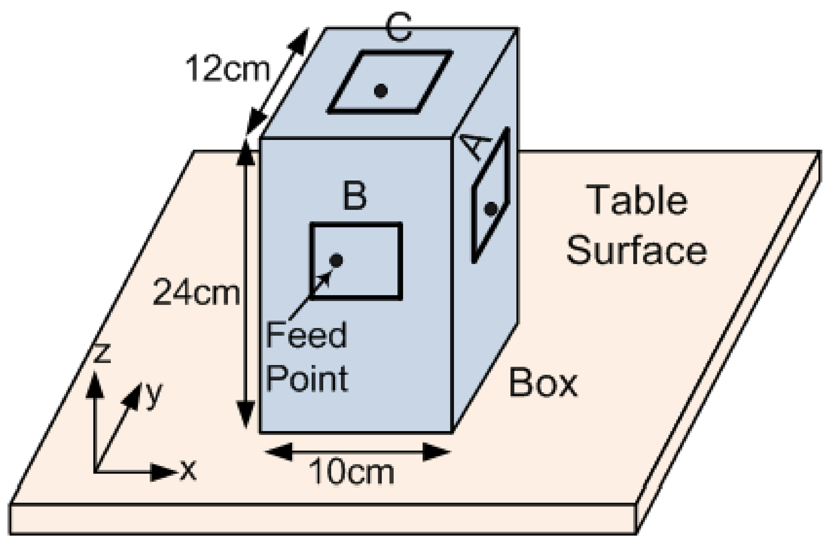


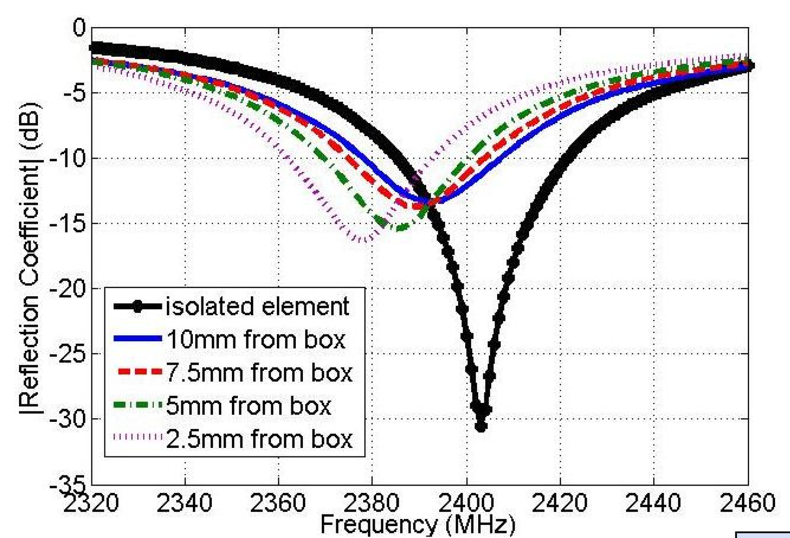
➢ FR4 (ε_r~4.5)
Relative to a monopole measured efficiency: ~40%

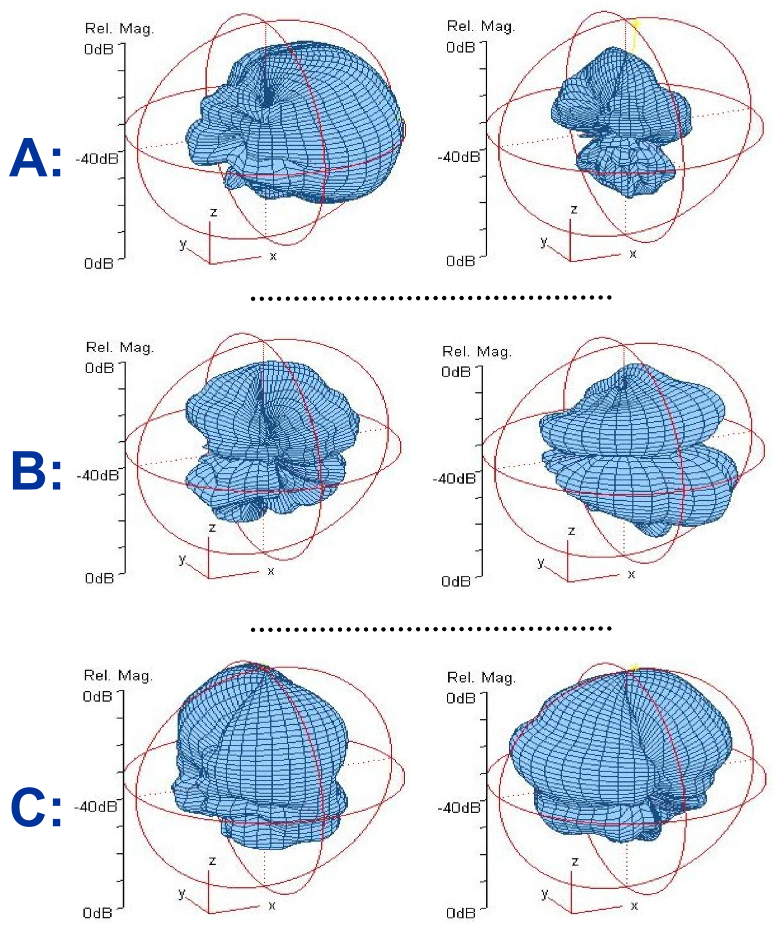
- Cost-efficiency trade-off: The use of the RT/Duroid substrate results in a 3dB improvement in performance over the significantly cheaper FR4
- HD video streaming applications: High demands in terms of throughput and packet-error-rate

Antenna input responses and radiation patterns

❖ Response for a three element array with RT/Duroid substrate







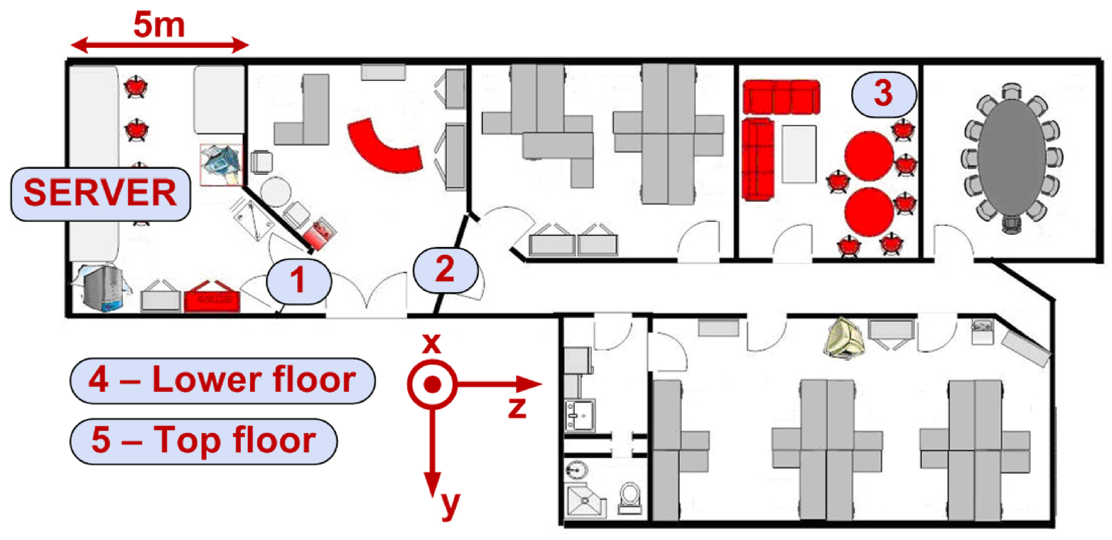
Effect of box and table:
- Antennas detuned by ~20MHz
- 'Identical' elements produce significantly different patterns and directivities

Element	Power in Polarisation (%)		Maximum Directivity (dBi)	
	Vertical	Horizontal	Vertical	Horizontal
A	95	5	7.6	-3.6
B	24	76	3.4	11.2
C	46	54	7.1	7.3
Isolated	98	2	8.0	-8.8

Measured system performance for an office environment

❖ 2x3 802.11n radio card in spatial multiplexing mode (server antennas B and C)

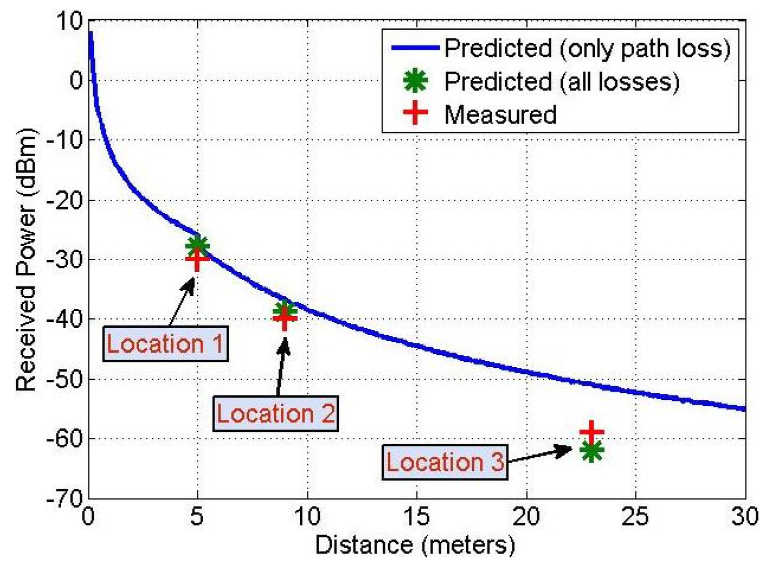
❖ Received power measured automatically by radio card; throughput and delay jitter using 'Iperf' (UDP protocol)



➢ Received power:
- Predicted link-budget:

$P_R = P_T + G_T – PL + G_R – L_{cables} – L_{walls}$

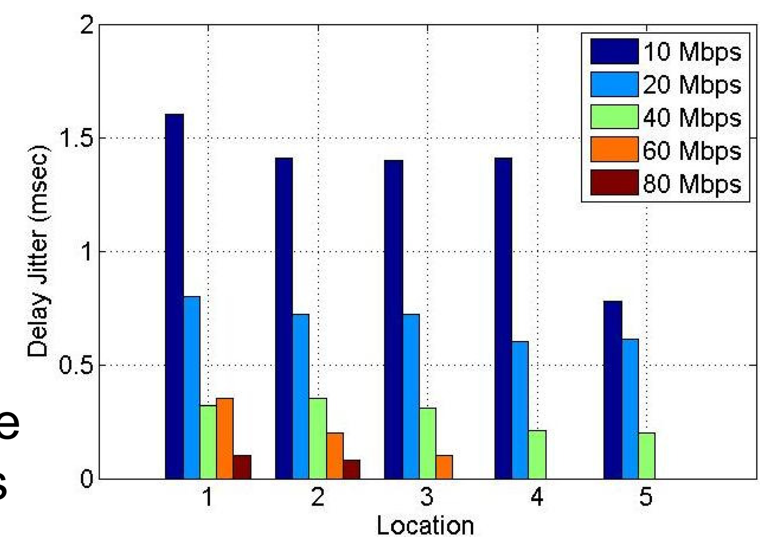
(P_T=12dBm; G_T=G_R=8.3dBi; L_{cables}=2dB; L_{walls}=3 dB/wall; PL=Path loss from TGn channel models)



➢ Throughput:
- MAC layer (datagram-error-rate<10%)
- Satisfying coverage possible in the whole office area (10-20Mbps normally necessary for HD video streaming applications)

	Locations				
	1	2	3	4	5
Throughput (Mbps)	80	80	60	40	40

➢ Delay jitter:
- Small values of delay jitter – unlike to cause problems in HD video streaming applications



❖ Results presented here are only for the 'best' orientation of the box in every location. Measurements for a large number of different box orientations in every location demonstrated differences of up to 18dB in the received power and up to 40Mbps in throughput.

Comparison with omnidirectional antennas

		Locations				
		1	2	3	4	5
Received Power (dBm)	Omnidirectional	-29	-39	-60	-60	-61
	Patches	-30	-40	-59	-71	-70
Throughput (Mbps)	Omnidirectional	80	60	40	60	60
	Patches	80	80	60	40	40

- Better performance with patch antennas on the same floor
- Poorer performance on top and lower floors (cannot achieve full 3D coverage)

Conclusions

➢ Efficiency comparison: The use of the RT/Duroid substrate results in a 3dB improvement in performance over the significantly cheaper FR4

➢ Significant impact of box and table mounting on input responses, radiation patterns and directivities – needs to be accounted for when designing antennas

➢ Satisfying coverage for HD video streaming in the whole office area (data rate at least 40Mbps) – Performance depends heavily on the box orientation (up to 40Mbps throughput differences)

➢ Better performance than omnidirectional antennas on the same floor but poorer on top and lower floors

➢ Antenna selection in future designs: Beneficial to overcome the problems of unpredictable box orientation and poor three-dimensional coverage

Acknowledgments:

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