Compatibility Challenges for Broadcast Networks and White Space Devices

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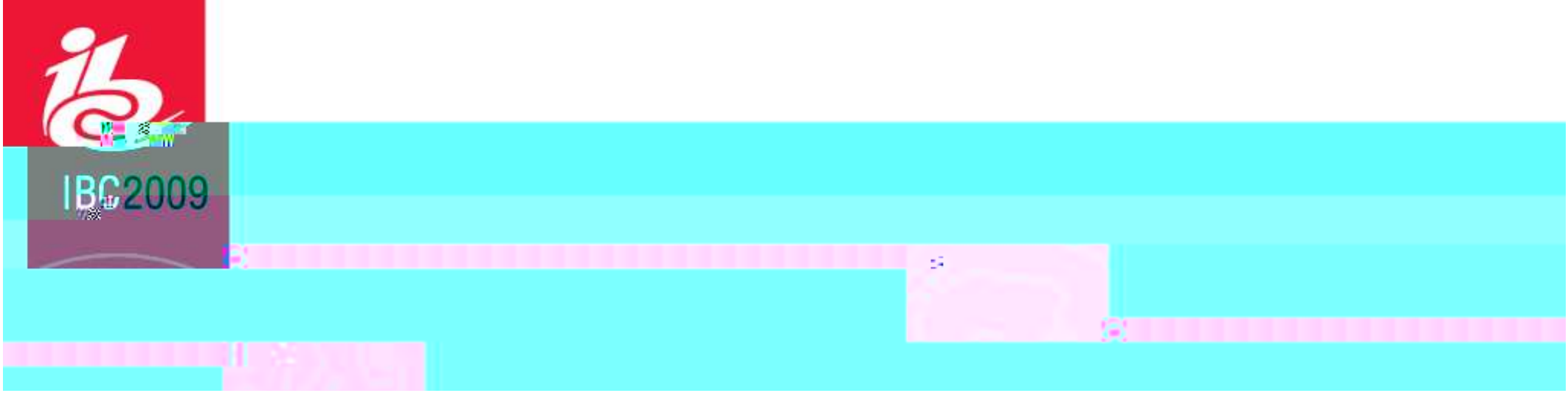
Overview

- Background
  - White space definition
  - UK digital switch over plan
  - Available white space spectrum
- White Space Applications
  - Existing licensed
  - Proposed licence-exempt (LE)
- Access Techniques - Cognitive Radio
  - Spectrum sensing
  - Geolocation
  - Beacons
- Technical Challenges
  - Spectrum sensing and the hidden node problem
  - ACI management
- Conclusions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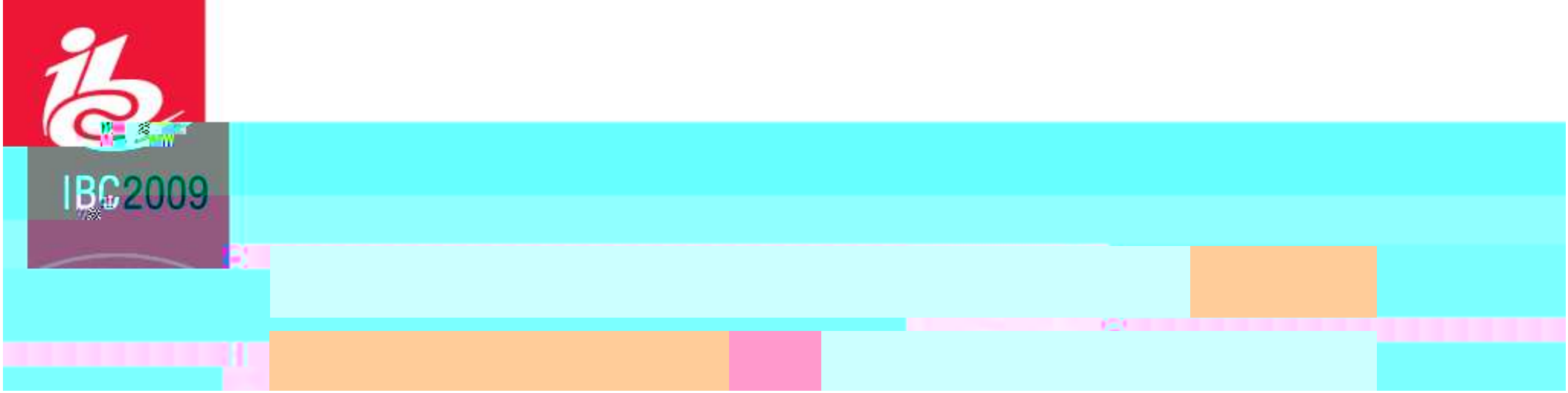
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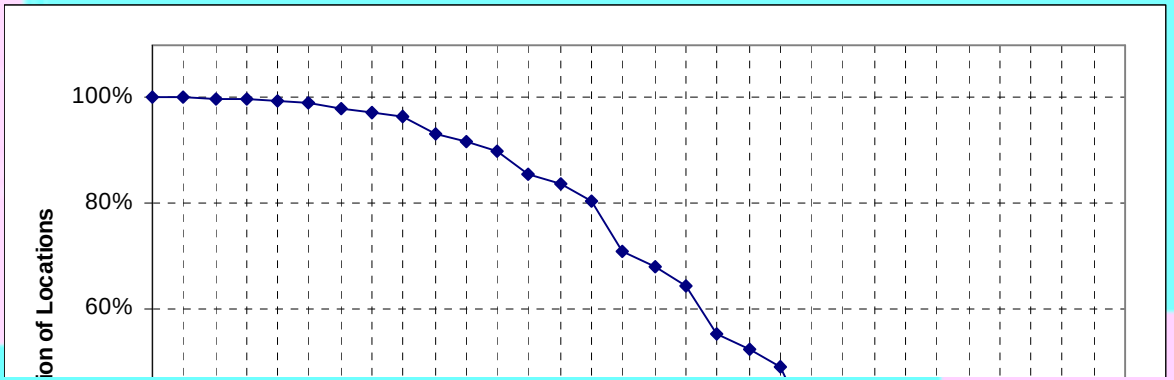
White Space Availability

- Naively, 256MHz DTT spectrum for 6 Multiplexes (48MHz)
- Increased use for TV Relays and at MFN boundaries
- Typically 50% of UK coverage area will have >150MHz White Space spectrum



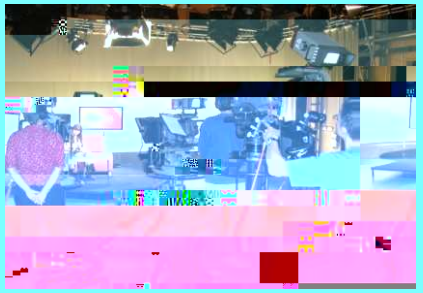
A Word of Caution....

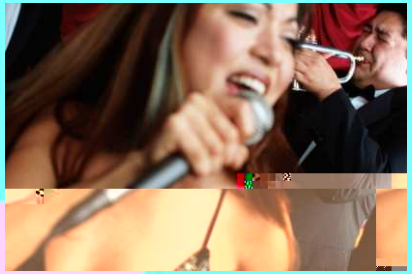
- 50% of coverage area not necessarily 50% of population
- Bottlenecks in densely populated areas where TV relay requirement is highest (e.g. London)
- Adjacent channel use of white space is restricted
  - ACI and OOB issues

Existing White Space Applications

Programme Making and Special Events (PMSE)

- Radio microphones (10 - 50mW EIRP)
- TV Studios, ENG ,Theatres
- Typically licensed by a band manager (JFMG in the UK)





New White Space Applications

- Broadband Wireless Access
  - Rural Area Networks (IEEE 802.22)
    - "ADSL-like" broadband networks operated by an ISP
    - Up to 4W EIRP (802.22 Draft)
    - Lower power RAN variant may suit denser TV network in Europe

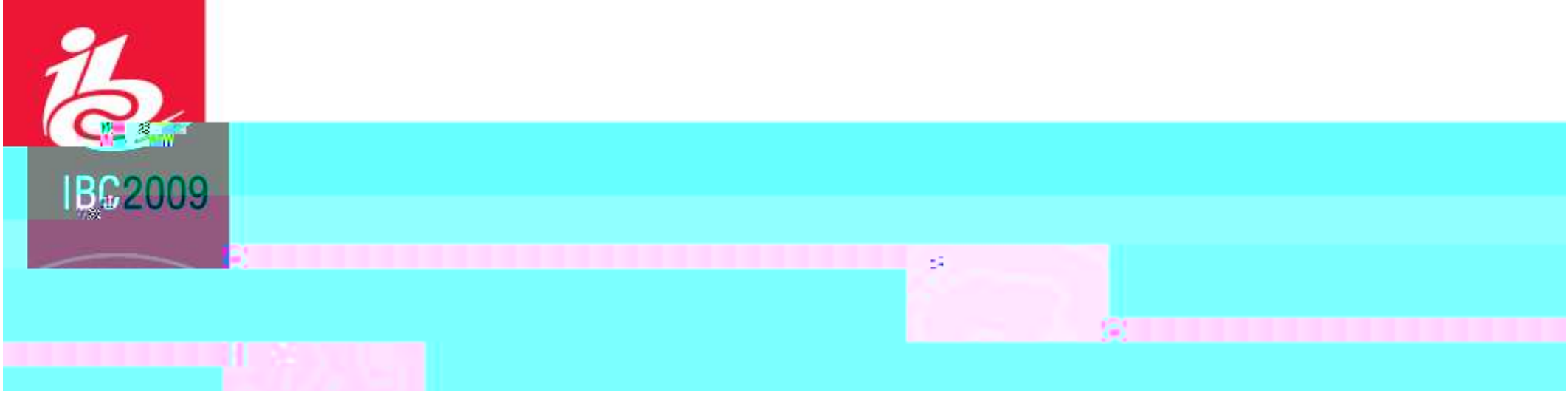
- In Home Networks
  - Improved WiFi (range & throughput)

White Space Access Techniques (UHF Cognitive Radio)

- Spectrum sensing

DTT Detection C/N Estimation

Required DTT CNR for QEF (64QAM rate 2/3)	19 dB
Planning Margin	8 dB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DTT Detection C/N Estimation

Required DTT CNR for QEF (64QAM rate 2/3)	19	dB
Planning Margin	8	dB
DTT antenna gain	12	dBi
WSD Antenna gain	-10	dBi
C/N loss at WSD antenna	-22	dB
Height loss	12	dB
Building penetration loss	7	dB
Location variation (95%)	14	dB
C/N losses due to location	-33	dB

Sensing Issues

- DTT typically buried in noise
- Detection very difficult

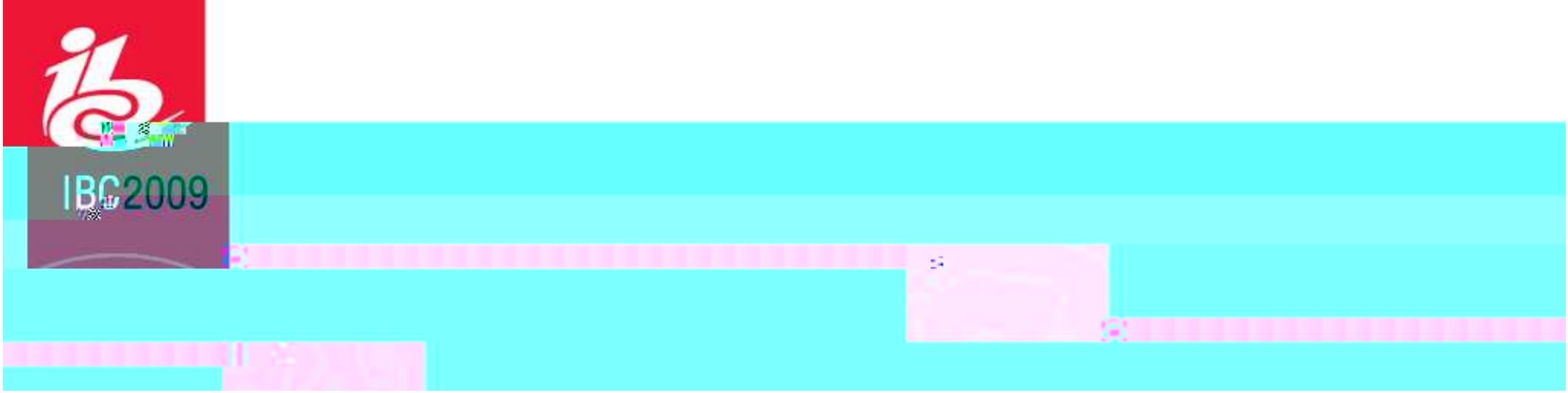
Adjacent Channel Interference (ACI) protection

- Adjacent and non adjacent devices can still interfere with DTT
- Need EIRP limits
  - Potentially location dependent using geolocation techniques to maximize WSD performance

Calculation of EIRP limits – ACI protection

- Consider C/I performance of receiver and planned DTT signal level to define maximum possible WSD interference level
- Calculate path loss from WSD to

Interference Scenario 1: WSD ground floor to fixed DTT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Comparison of required EIRP

Comparison of required EIRP limits with Regulator Proposals

Scenario	EIRP Protection requirement		FCC-8-260 14/11/08	
	Outdoor	Loft	Mobile	Fixed
Adjacent Channel Use	+3dBm	-15dBm	+16dBm	-

Comparison of required EIRP limits with Regulator Proposals

Scenario	EIRP Protection requirement		FCC-8-260 14/11/08		Ofcom 1/7/09
	Outdoor	Loft	Mobile	Fixed	
Adjacent Channel Use	+3dBm	-15dBm	+16dBm	-	+4dBm

Conclusions

- White Space Devices can potentially enable new applications
  - Mobile broadband, home networks & RANs
- Sensing very difficult to engineer
- Geolocation emerging as preferred access solution for CCI prevention

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Thank you !

- Questions ?