



Femtocells: The Market and Technology

Femtocells, LTE and the New Radio Revolution

IET, 18th May 2011

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The Femto Forum

- Promoting & enabling femtocells
- Not-for-profit, founded in 2007
- Independent, Inclusive, International

driving convergence worldwide

Aims

- Ecosystem Development
- Market Education
- Driving open standards



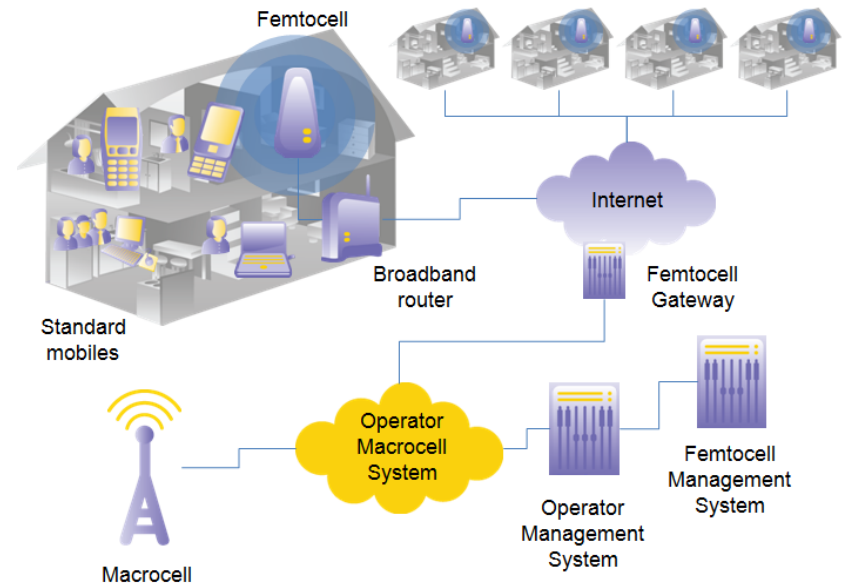
63 operators covering 1.7 billion mobile subscribers – 33% of total

74 providers of femtocell technology

What are femtocells?

- Low-power access points...
 - ...using mature mobile technology
 - ...in licensed spectrum
 - ...generating coverage and capacity
 - ...over internet-grade backhaul
 - ...at low prices
 - ...with full operator management
 - ...self-organising, self-managing

- Applications include:
 - Residential
 - Enterprise
 - Hot spot
 - Metro



Generic Femto Network Architecture Standards in place for:

- UMTS
- LTE
- CDMA
- WiMAX



driving convergence worldwide

Some Femtocell Access Points



Per ricevere sempre il miglior segnale mobile a casa tua o in ufficio



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Identified and Overcame Deployment Barriers

Business Case

Femto Forum publishes detailed findings from femtocell business case study

New results show femtocell business case is both positive and robust to varying operator situations, and can even work on cost savings alone for heavy data users.

Spectrum Efficiency

FEMTO FORUM STUDY CONCLUDES THAT CELL-TO-CELL INTERFERENCE BETWEEN FEMTOCELLS AND THE MACRO NETWORK IS NOT A BARRIER TO DEPLOYMENT

Femtocells can deliver a significant increase in mobile network capacity and play a key role in increasing mobile data speeds

Standards

Worlds first femtocell standard published by 3GPP

News Archives

Three-way cooperation between 3GPP, Femto Forum and Broadband Forum creates new standard in record time enabling operators to deploy standards-based femtocells

Ecosystem

End-to-end system producers 		Other enablers
Products 	Network Elements 	
Components & Software 		



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Key Findings Global Femtocell Survey

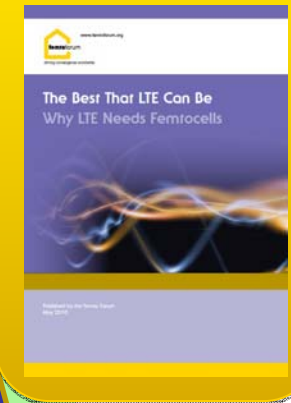


60% of consumers are interested in femtocells

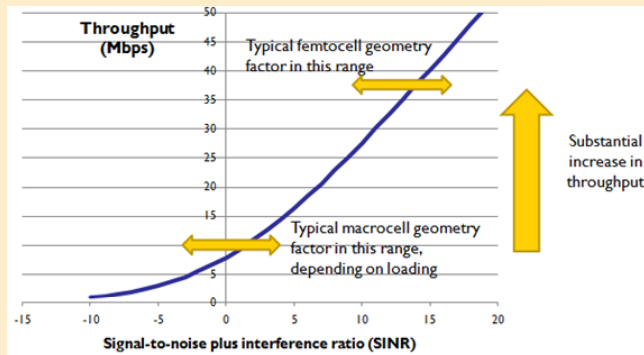
- Voice coverage**
 - Main driver for femtocells is in-building voice coverage – and is main driver for consumer rating of mobile operator
- Churn Reduction**
 - Voice service improvement alone could prevent 42% of consumers switching operator in the next 12 months
- Wi-Fi complementary**
 - 83% of heavy Wi-Fi phone users find femtocells very/extremely appealing
- Added-value services**
 - 68% of femtocell fans found at least one advanced femtocell service very/extremely appealing

Femtocells in LTE Systems

Details in white paper



Performance



Business Case

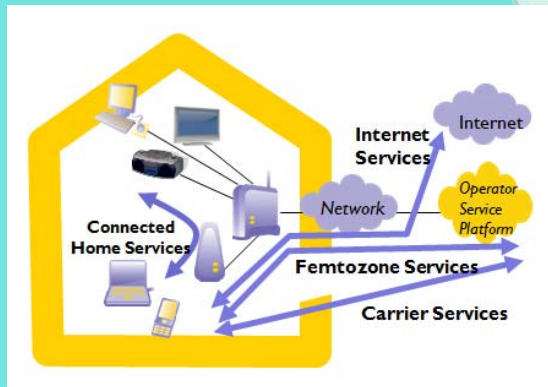
Revenue impact

Time-to-market

Cost savings

LTE Femtocells

Services



Deployment Approaches

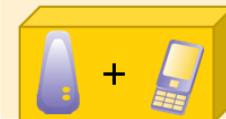
Femto-centric next-gen introduction

- Build femto first



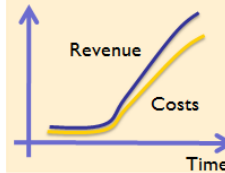
Next-gen femto quick-start package

- Provide next-gen user device and femto to early adopters



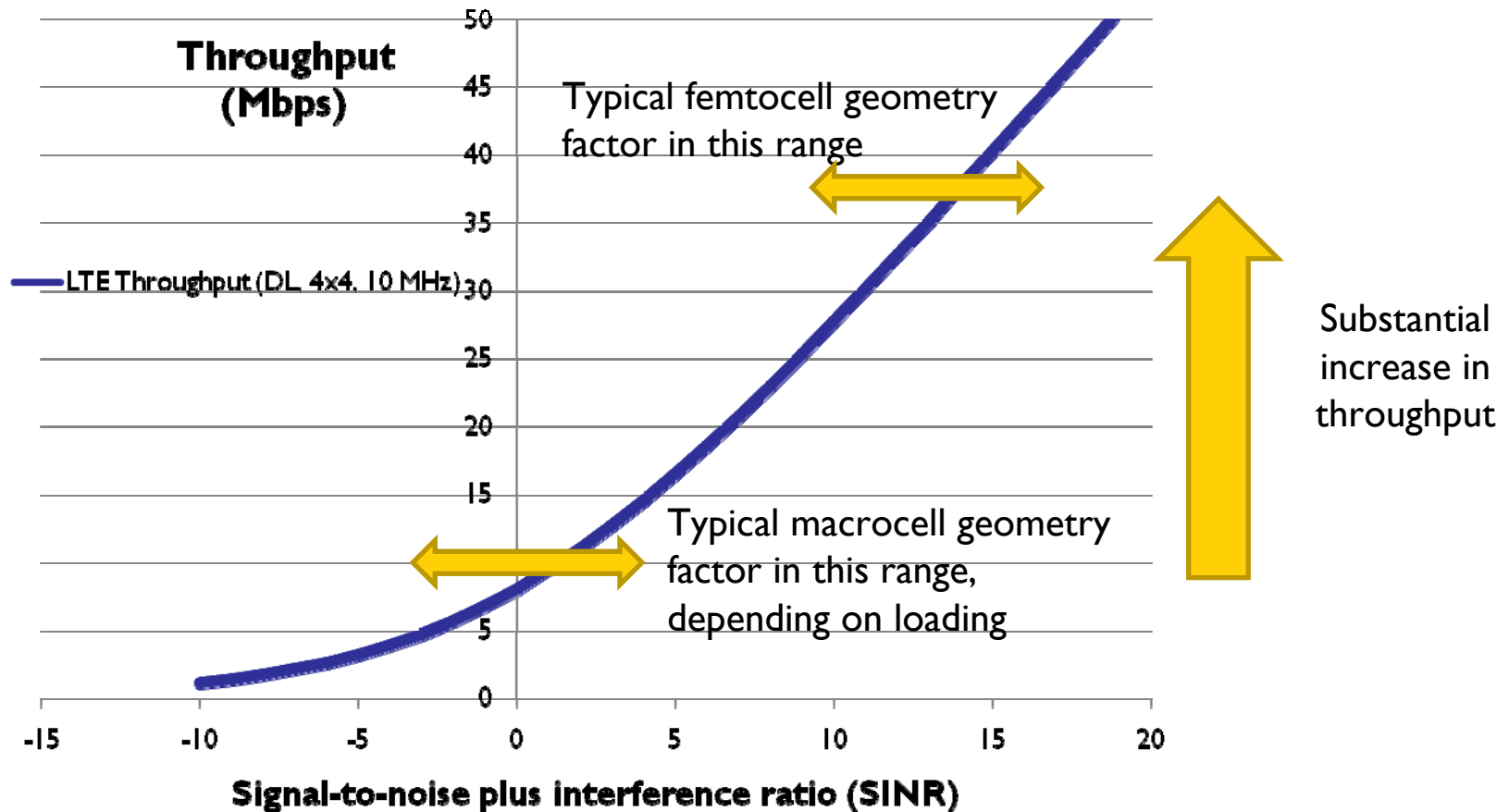
Match costs to revenues

- Avoid 'build it and they will come'



Higher Rates from Lower Interference

- High SINR and low contention deliver near-peak rate performance throughout coverage area

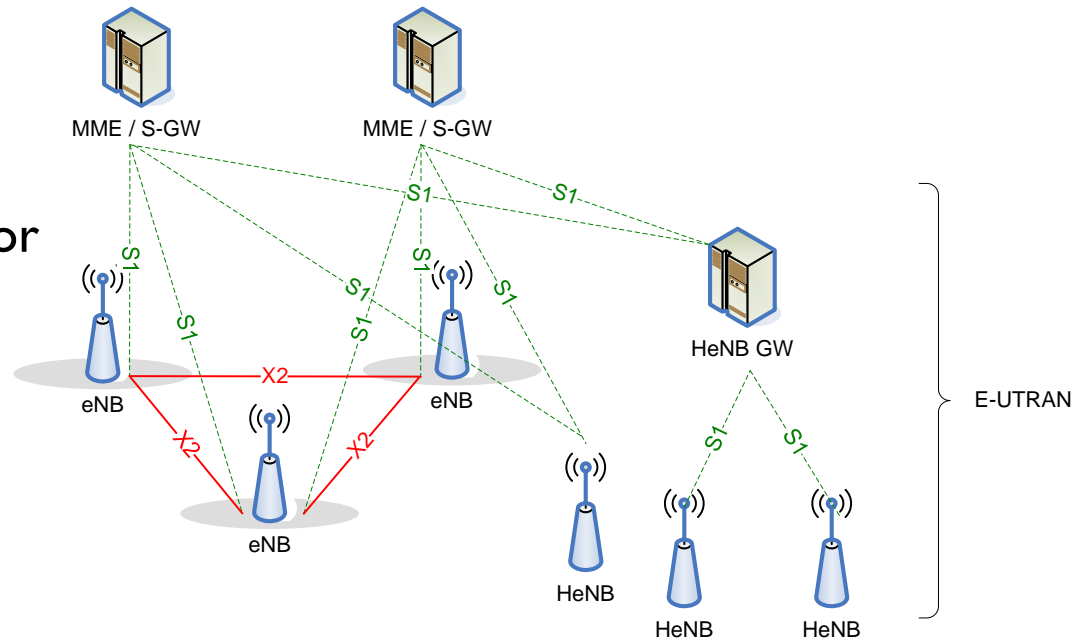




LTE Femtocell Standards



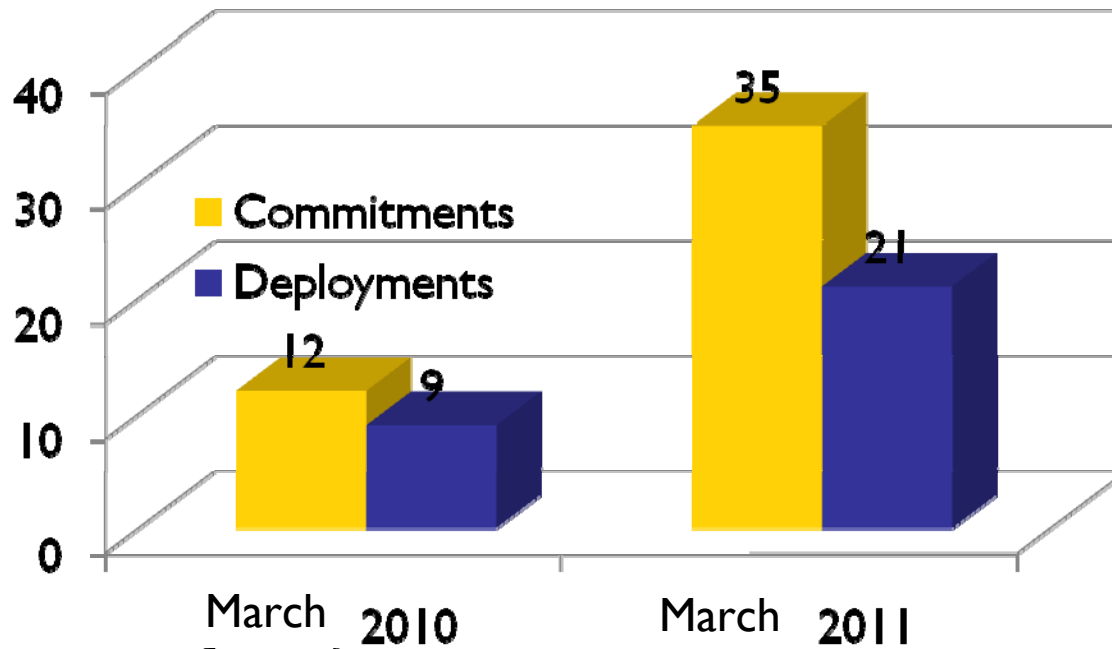
- Femto Forum supports LTE femtocell standards via Partnerships with 3GPP and Broadband Forum
- 3GPP Release 9 delivered a full end-to-end LTE femtocell standard with several options for the architecture and an open management protocol
- Femto Forum issued a white paper yesterday highlighting the merits of the architectural options



Femtocells are an accepted part of LTE standards for the long term



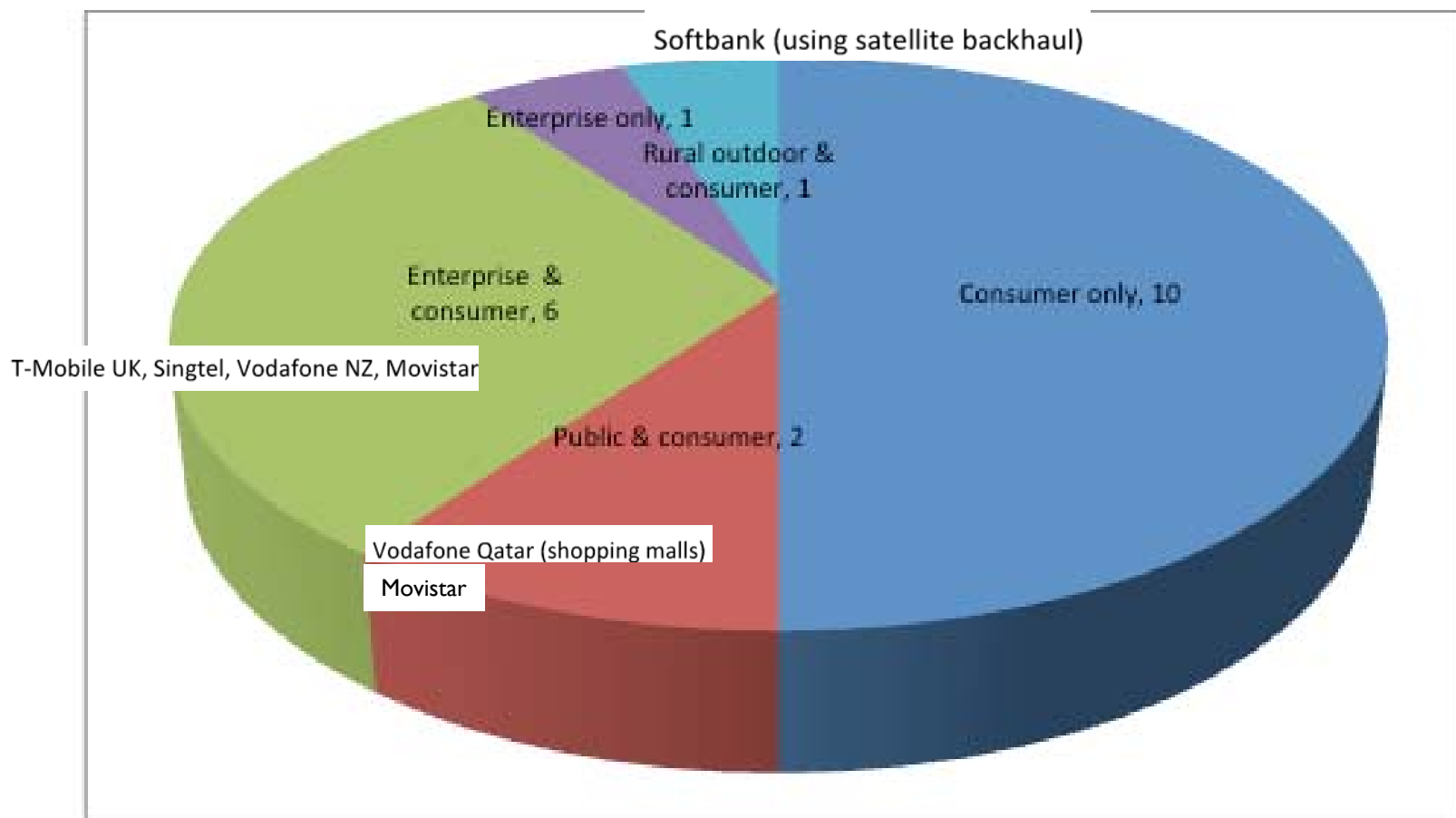
Strong Growth in Deployments and Commitments



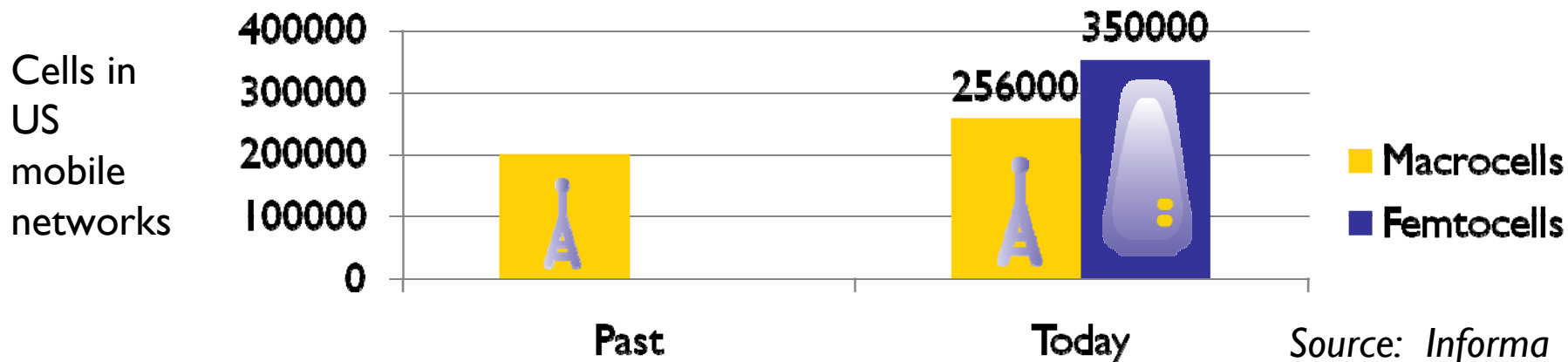
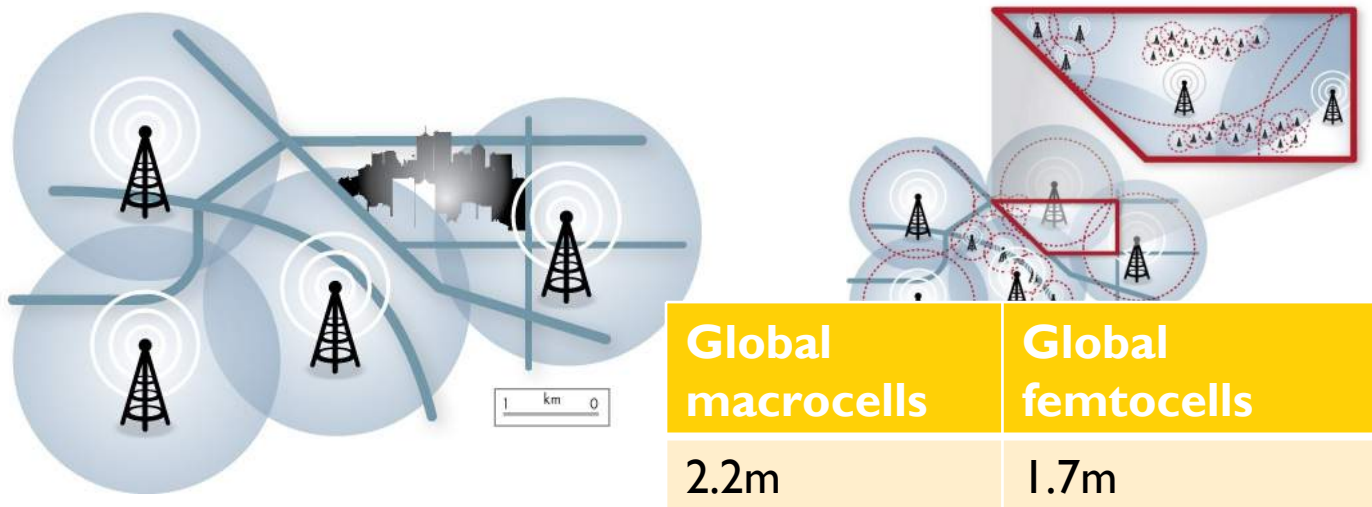
movistar



Diversifying Deployments



The shape of mobile networks has changed...





Summary

- **The industry ecosystem for femtocells is well developed**
- **The technical model for femtocells is well-proven, including automated interference management**
- **Commercial deployments are growing strongly, building on positive consumer feedback**
- **Femto technology now addresses home, office and metro environments**
- **LTE femtocells are supported by a strong standards-based architecture**

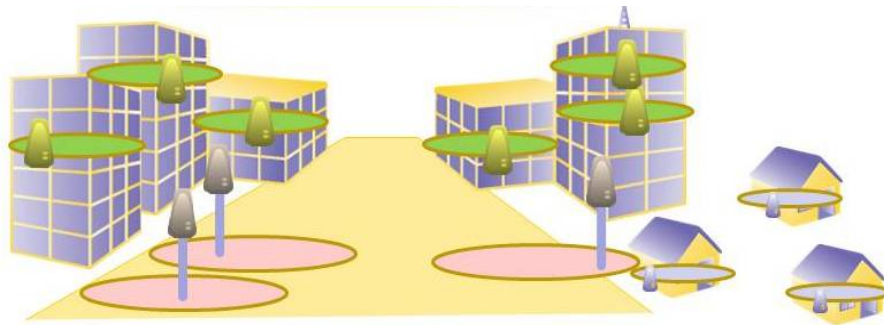
22 March 2011 Last updated at 15:51

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Ofcom launches next-generation 4G consultation

The telecoms regulator has launched a consultation on how best to sell off the rights to the next generation of mobile wireless networks.



Ofcom outlines auction rules for 4G spectrum

By Andrew Parker

Published: March 22 2011 09:25 | Last updated: March 22 2011 21:06

C&W Worldwide could use the so-called low-power spectrum to offer mobile phone and data services to corporate customers in specific locations.

Low-power 4G Spectrum: Ofcom's Bold New Proposal

ABI Research

Whatever the outcome, the award of specific low-power 4G spectrum bands should give regulators in other parts of the world, especially the US and other European countries, some food for thought.

Low-power shared access to spectrum for mobile broadband

Key Findings from our study for Ofcom

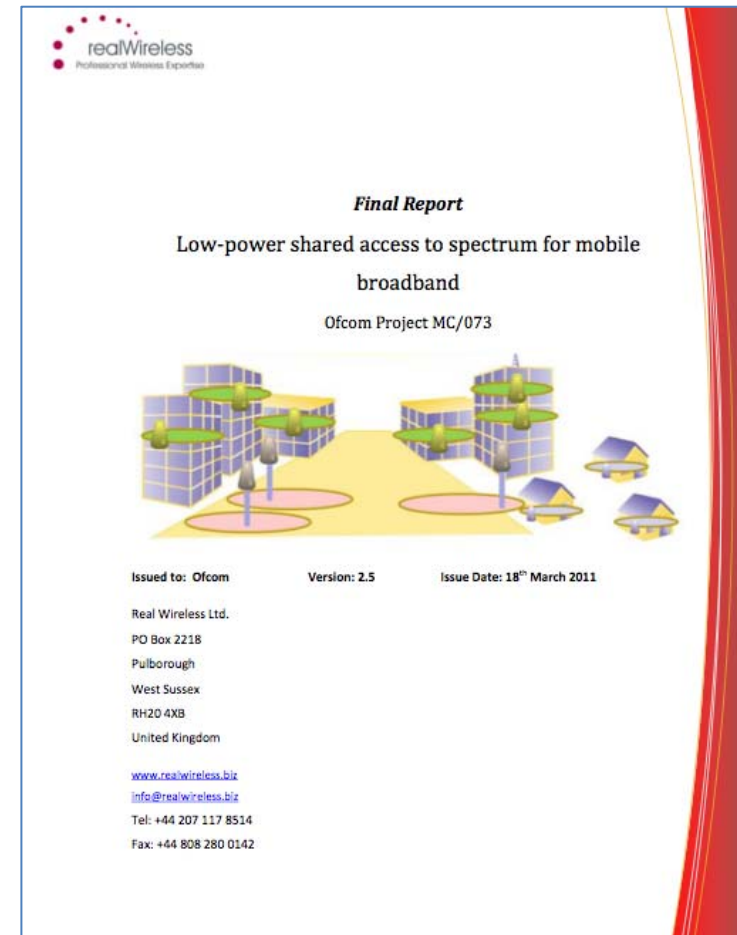
Real Wireless: info@realwireless.biz

18th May 2011

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Notes on this presentation

- While this study was conducted for Ofcom, the views presented here are those of Real Wireless and not Ofcom
- This presentation summarises Real Wireless' findings on "Low-power shared access to spectrum for mobile broadband". The results and conclusions presented here may not necessarily be translated into any subsequent auction rules.
- Our study reflects a "challenging but realistic" case analysis to determine upper and lower regulatory limits. Any potential bidders for spectrum should carry out their own analysis specific to their own target services.



Full report available alongside main Ofcom consultation document from:
<http://stakeholders.ofcom.org.uk/consultations/combined-award/>

Key questions from Ofcom

Coverage

- What would be suitable EIRP and antenna height limits for low-power devices in likely deployment scenarios?

Co-channel interference

- What separation distances and other interference mitigation would be needed between low power access points and between low power access points and surrounding macrocells (in the case of underlay or hybrid access)

Adjacent channel interference

- Is there any benefit in locating a low-power band at the upper end of the FDD band?

Trade-offs relating to spectrum quantity

- How big should a low-power band be and should it be dedicated, underlay or hybrid spectrum?

Comparison with DECT guard band and Wi-Fi

DECT Guard Band

- ✓ No scope for traditional frequency reuse, but distributed frequency partitioning and fractional frequency reuse available
- ✓ Automated interference mitigation for femtocells now proven in standards and practice
- ✓ Data-oriented systems not so influenced by temporary loss of quality
- ✓ LTE far higher spectrum efficiency than GSM, so more capacity for equivalent interference conditions
- ✓ Higher propagation losses for 2.6 GHz so smaller distances for equivalent protection

Technical conditions should be less stringent than guard band award

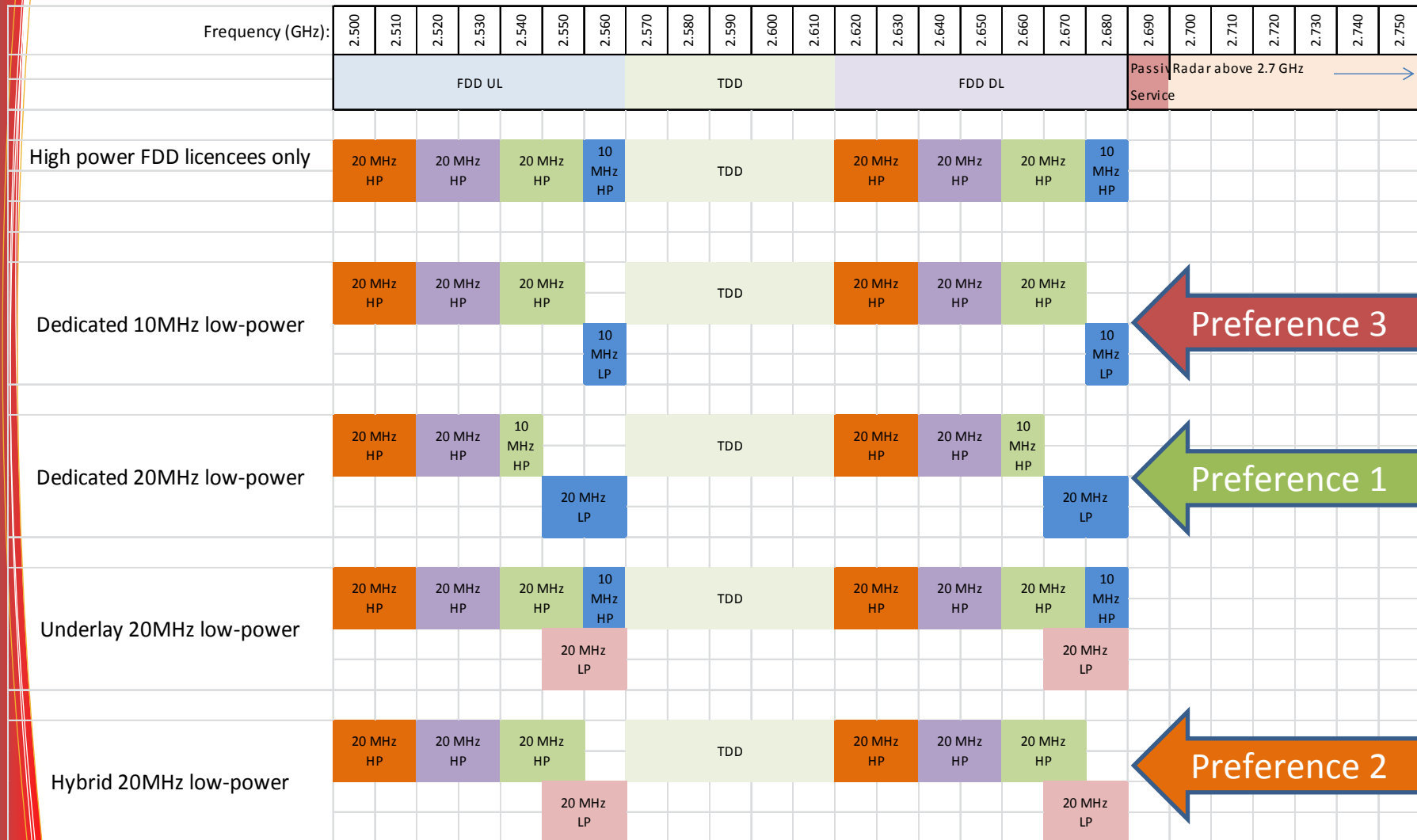
2.4 GHz Wi-Fi

- ✓ Limited no. of operators
- ✓ Managed protocol with assured QoS
- ✓ All devices can adopt common protocols and interference management conventions
- ✓ Uplink power control
- ✓ Downlink power control
- ✓ Proven interference mitigation techniques
- ✓ Support for full mobility
- ✓ Scope for handover to wide area systems
- X Smaller spectrum bandwidth

Performance should be better than Wi-Fi even if analysis of 'challenging' interference conditions indicates degradation

Spectrum quantity recommendations

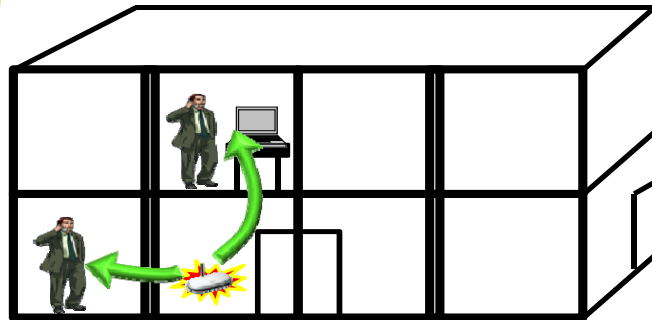
- *Based on the utility of the LP allocation*



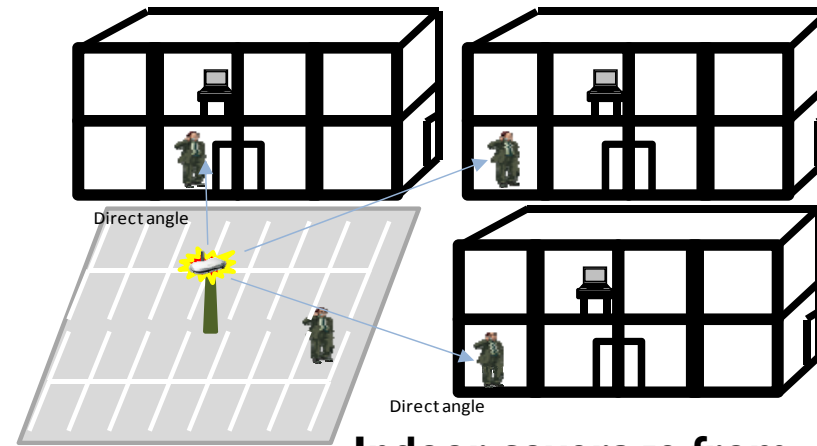
N.B. Location of shared channel for illustration only

Coverage

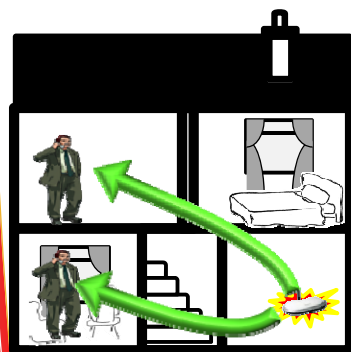
We examined coverage in likely deployment scenarios:



Indoor office coverage



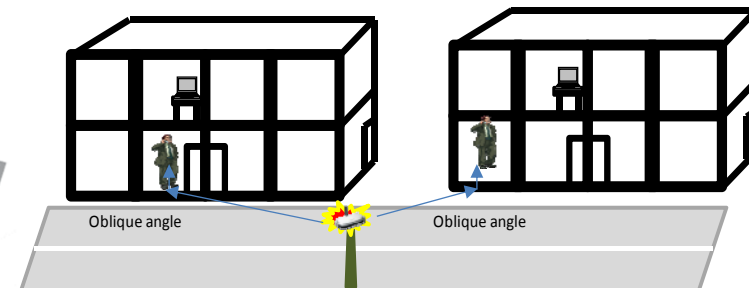
Indoor coverage from external access points in a campus or business park



Indoor residential coverage



Coverage in a public area

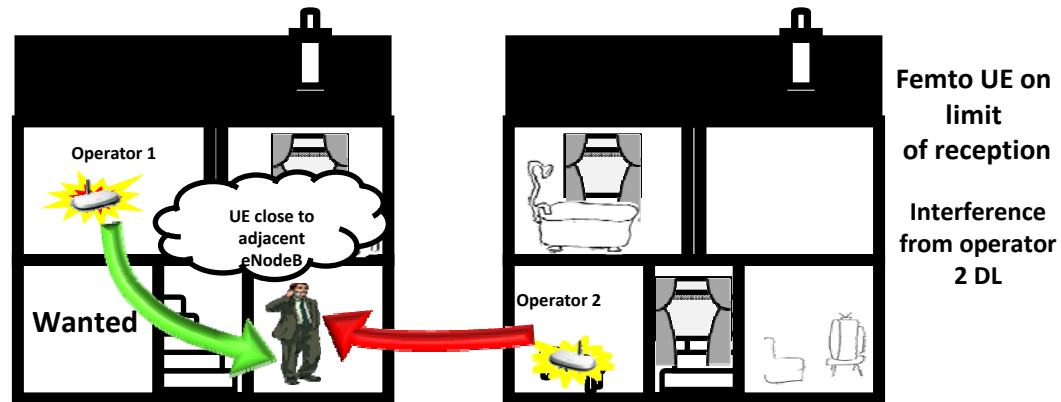


Indoor coverage from a street

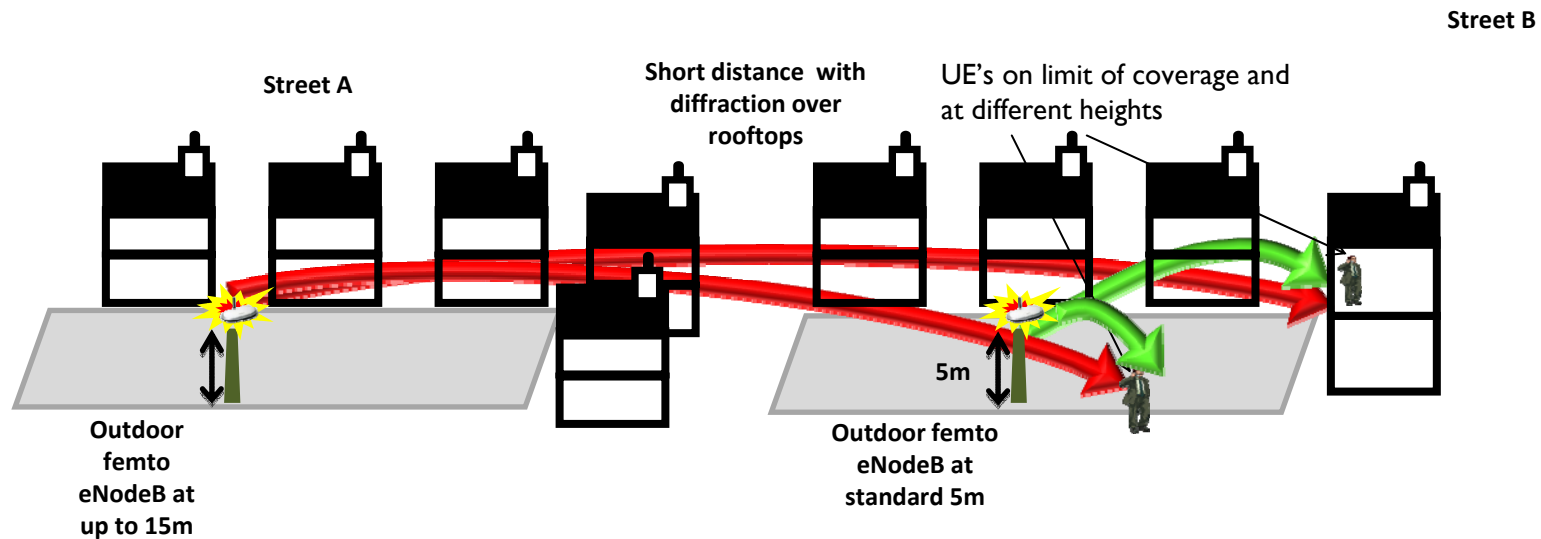
Key findings - Coverage

- **Indoor office:** single floor of medium sized office at 27 dBm EIRP (0.5W) and potentially lower
- **Indoor public area:** 27 dBm provides maximum data rates over 8,000 m²
- **Homes:** 20 dBm (100 mW) covers most homes at maximum data rate, but large homes may require 23 dBm (200 mW)
- **Campus / business park:** Indoor coverage from outdoors inadequate at 20-25 dBm. 30 dBm (1W) would allow a 100m microcell to deliver good indoor penetration

Co-channel interference

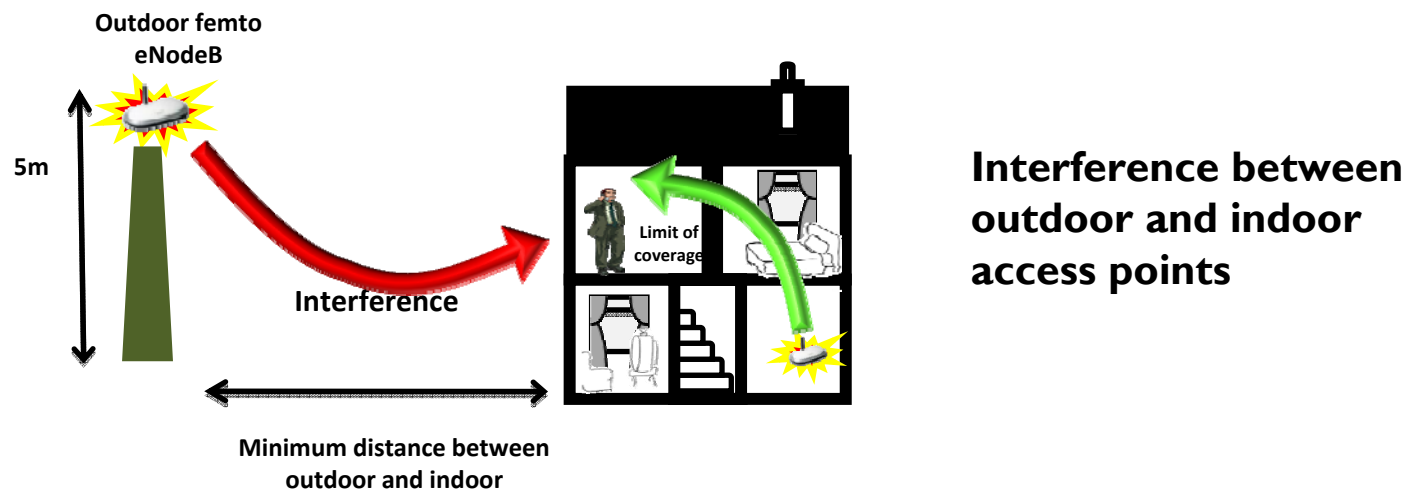
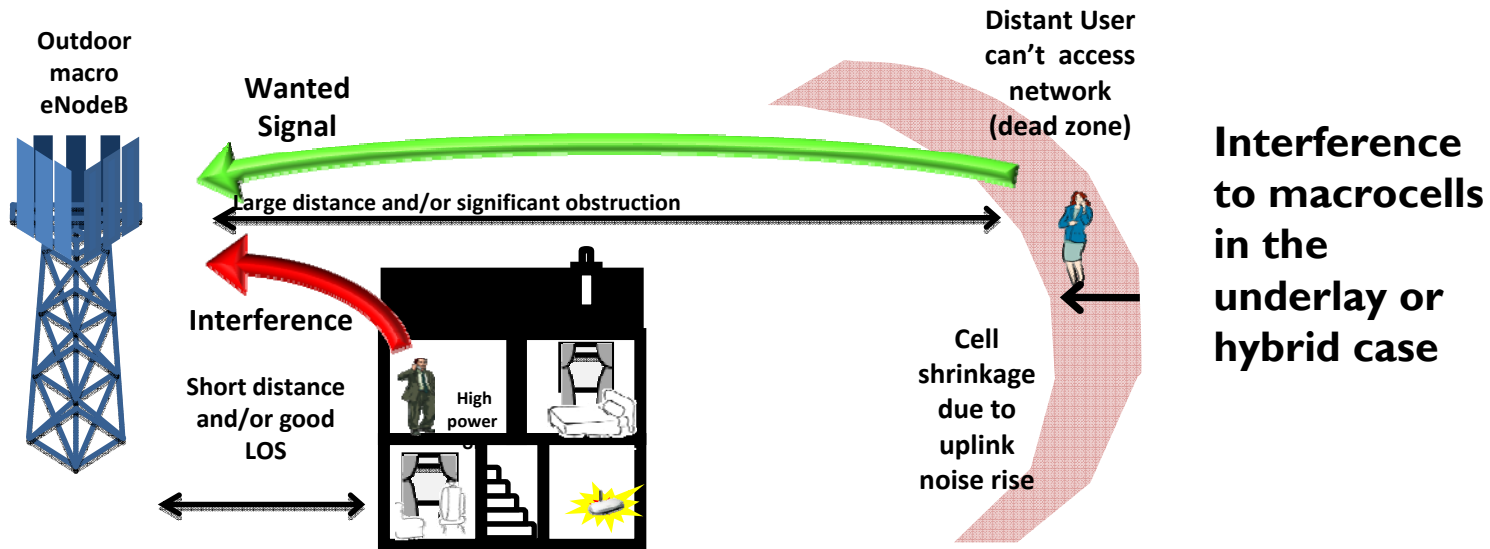


Separation distances between houses



Maximum outdoor antenna height

Co-channel interference



Key findings – Co-channel Interference

- **Minimum separation between houses:** *Can be as low as zero* for 50% cell edge degradation due to scheduler operation with one dominant interferer. For cell edge degradation below 50% separation distances of above 25m are needed.
- **Outdoor antenna heights:** *Should be near to typical residential heights: 12m suggested* for consistency with typical street furniture antennas. The interference range depends on the transmit power and buildings assumed. In our residential example interference ranges of 50-100m were typical at 10m mast heights.
- **Hybrid arrangement interference to macrocells:** *500m-2km separation needed for 20-40% cell edge throughput degradation:* affects many users
- **Outdoor low power to indoor low power:** 100-450m separation needed depending on targets: *coordination needed amongst operators for this and any case where multiple operators target overlapping coverage*

NB control channel interference requires explicit measures to avoid interference, potentially limiting to 7/14 collocated operators in 10/20 MHz

Measures amongst Low-power Operators

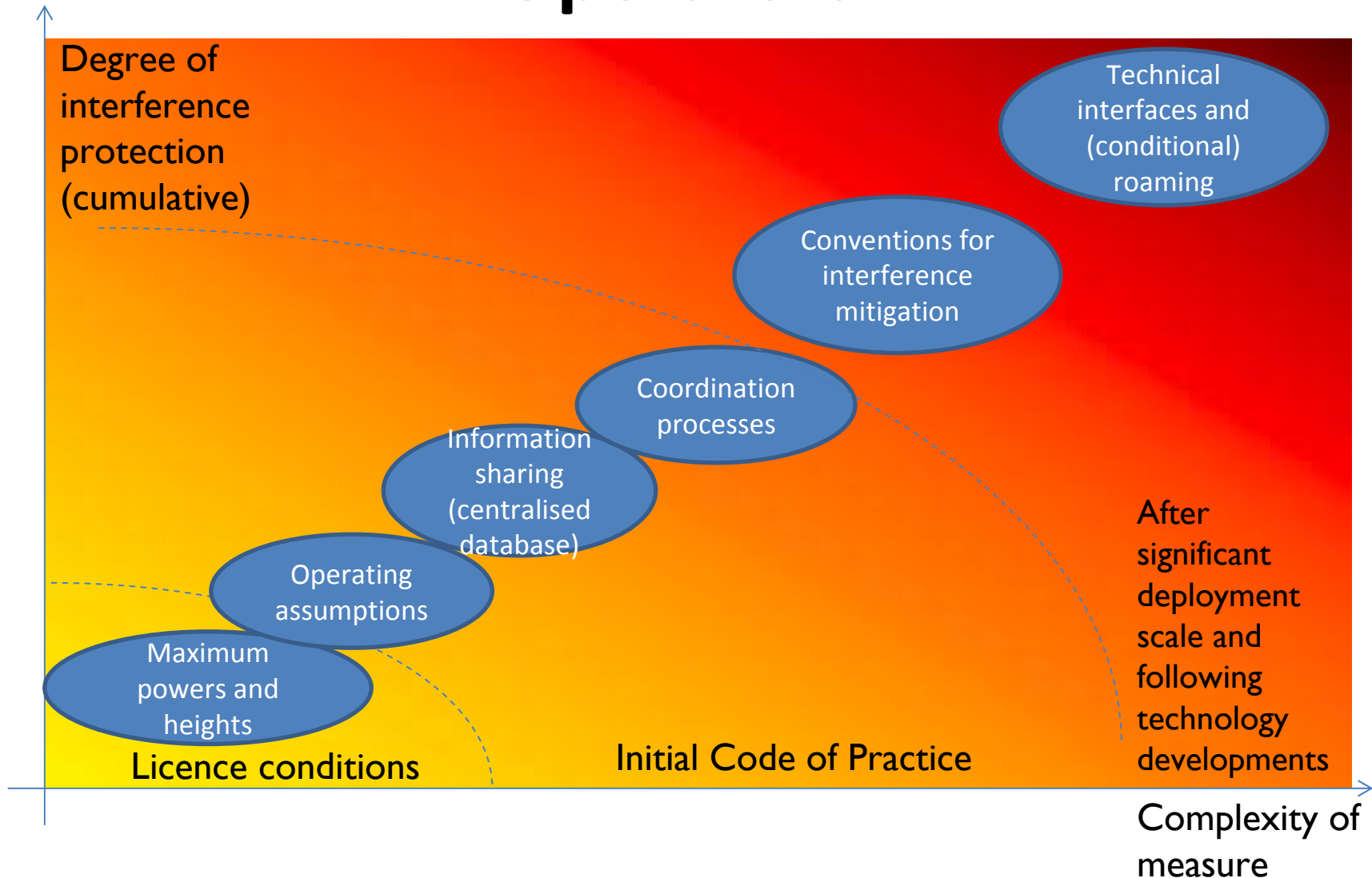
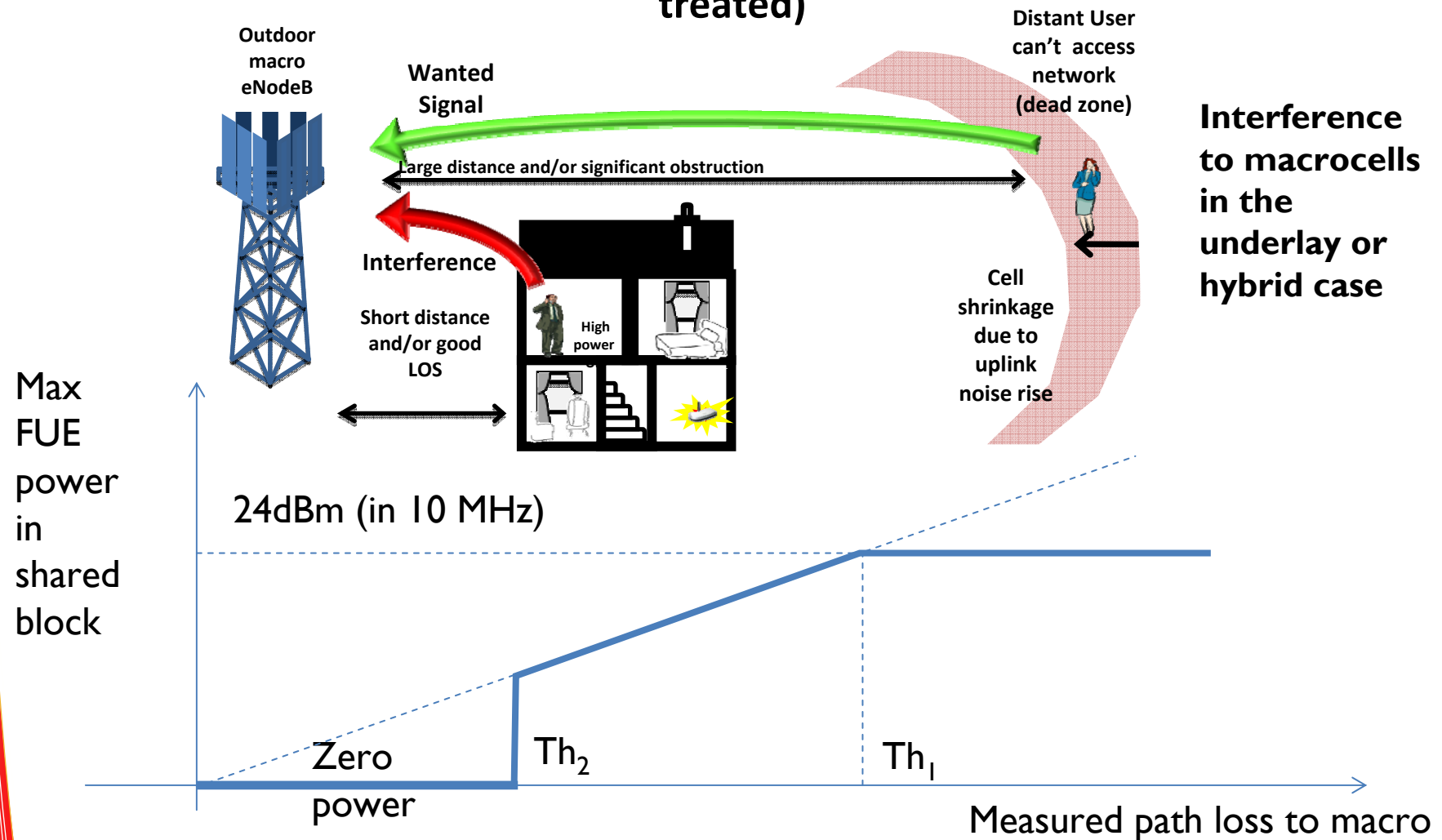


Illustration of hybrid protection clause operation

(Only UL noise rise scenario are shown: other issues also need to be treated)



Headline recommendations fed into the consultation

1. **Ideally 2 x 20 MHz for low power access** with adequate protection against interference consistent with high capacity and peak throughput, in *dedicated or hybrid* configuration: avoid full underlay due to challenging interference cases in the absence of roaming
2. **EIRP of up to 30 dBm** in line with 3GPP local area base station specification with moderate antenna gain (+5 dBi) to deliver adequate indoor coverage from outdoors. **Transmit power control is assumed**, so most installations will use far less than this (less than 20 dBm for most houses)
3. **Maximum outdoor antenna height of 12m** to avoid excessive interference range
4. **Code of practice amongst operators** to ensure 'fair' approaches to distributed interference mitigation and to set conventions for frequency partitioning
5. **Maximum number of operators mainly a policy issue**: technical considerations are set by 'nearest' neighbour, overlapping deployments simply share capacity if coordinated (major degradation if not). **7-14 operators entirely plausible**.