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**femtoforum**

driving convergence worldwide

Prof. Simon Saunders  
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To: Roger B. Marks, Chair IEEE 802.16

Re: **ITU-R Working Party 5D Request for Information on Femtocells**

Dear Roger

Femto Forum is currently considering its response to the above request for information and understand that this request has also been sent to your organisation. We have attached our draft response for your information and would welcome your own comments in advance of our submission. If there is scope for us to harmonise the responses from our organisations we would welcome further discussion with you.

Yours sincerely,

**Prof. Simon Saunders**  
**Chairman, Femto Forum**  
**Chairman, Femto Forum Regulatory Working Group**



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[date to be inserted]

To: Colin Langtry, Counsellor, ITU-R SG 5, [colin.langtry@itu.int](mailto:colin.langtry@itu.int)

Re: **ITU-R Working Party 5D Request for Information on Femtocells**

Dear Colin

I write following your request for information on femtocells dated 16<sup>th</sup> February 2009. I am pleased to provide the attached response, which has been produced following consultation with Femto Forum members worldwide [and following consultation with the following other organisations...].

The Femto Forum is the only organisation devoted to promoting femtocell technology worldwide. It is a not-for-profit membership organisation, with membership open to providers of femtocell technology and to operators with spectrum licences for providing mobile services. The Forum is international, representing more than 100 members from three continents and all parts of the femtocell industry, including:

- Major operators
- Major infrastructure vendors
- Specialist femtocell vendors
- Vendors of components, subsystems, silicon and software necessary to create femtocells

Please see [www.femtoforum.org](http://www.femtoforum.org) for a full list of members.

Femto Forum has an active regulatory working group encouraging a consistent regulatory environment in a wide range of administrations, and helping to ensure that any necessary clarification is identified and dealt with ahead of the time at which operators wish to provide services, permitting the regulatory benefits of femtocells to be achieved in a timely fashion. We have published a white paper on Regulatory Aspects of Femtocells, which can be found on our website at [www.femtoforum.org](http://www.femtoforum.org)

We welcome ITU-R WP5D's interest in femtocells. However we would note that the creation of a fixed definition of femtocells may not reflect the fast-moving and innovative nature of the femtocell industry,

where the definition has already evolved substantially over the two year history of the Femto Forum. This contrasts with the rather precise definitions of equipment categories within the relevant standards organisations. We note that there is no formal definition of “macrocells”, “microcells” and “picocells”.

We would welcome further dialogue with you regarding these matters, since our members represent the majority of the femtocell industry worldwide and would be pleased to provide informed response to further queries you may have on these topics and others.

Yours sincerely,

[signature]

**Prof. Simon Saunders**  
**Chairman, Femto Forum**  
**Chairman, Femto Forum Regulatory Working Group**



## Femto Forum Response to ITU-R Working Party 5D Request for Information on Femtocells

- 1) What is your organization's definition of a femtocell (or equivalent)?
  - a) Please provide a general description.
  - b) What types of femtocells (or equivalent) are currently being defined by your organization?

A femtocell is a low-power wireless access point, incorporating *all* of the following attributes:

- **Operating in licensed spectrum:** By operating in licensed spectrum licensed to the network operator, femtocells allow operators to provide assured quality of service to customers over the air, free from harmful interference but making efficient use of their spectrum. To ensure that the femtocell can only be operated within the geographical area covered by the spectrum license, the geographical location of the femtocell is checked and reported to the mobile network operator before the femtocell is allowed to transmit.
- **Using mobile technology:** Femtocells use fully standard wireless protocols over the air to communicate with standard mobile devices, including mobile phones and a wide range of other mobile-enabled devices. Qualifying standard protocols include GSM, W-CDMA, LTE, Mobile WiMAX, CDMA, TD-SCDMA and other current and future protocols standardised by 3GPP, 3GPP2 and the IEEE, which collectively comprise the technologies included in the ITU-R definition of IMT. The use of such protocols allows femtocells to provide services to several billion existing mobile devices worldwide and to provide services which users can access from almost any location as part of a wide-area network.
- **Generating coverage and capacity:** As well as improving coverage within the home, femtocells also create extra network capacity, serving a greater number of users with high data-rate services. They differ in this from simple repeaters or 'boosters' which may only enhance the coverage.
- **Over Internet-grade backhaul:** Femtocells backhaul their data over internet-grade broadband connections, including DSL and cable, using standard internet protocols. This may be over a specific Internet-service provider's network, over the Internet itself or over a dedicated link.

- **At low prices:** The large volumes envisaged for femtocells will allow substantial economies of scale, driving efficiencies in manufacturing and distribution in a manner similar to the consumer electronics industry and with pricing projected to be comparable with access points for other wireless technologies.
- **Fully managed by licensed operators:** Femtocells only operate within parameters set by the licensed operator. While they have a high degree of intelligence to automatically ensure that they operate at power levels and frequencies which are unlikely to create interference, the limits on these parameters are always set by operators, not the end user. The operator is always able to create or deny service to individual femtocells or users. This control is maintained whether the femtocell itself is owned by the operator or the end user.
- **Self-organising and self-managing:** Femtocells can be installed by the end customer. They set themselves up to operate with high performance according to the local and network-wide conditions regarding radio, regulatory and operator policies, with no need for local intervention by the operator. They continue to adjust themselves over time as the customer, operator and regulator needs evolve to maximise performance and reliability.

Individual femtocells are likely to come in various hardware types. Although individual standards differ in their definitions, the following broad classes can be identified, though these are not exclusive or prescriptive:

- **Class 1** This is the class of femtocells which has emerged first and is currently best-known. Similar power and deployment view to Wi-Fi access points (e.g. typically 20 dBm of radiated power<sup>1</sup> or less), for residential or enterprise application. They will each deliver typically 4-8 simultaneous voice channels plus data services, supporting closed or open access. Installed by the end-user.
- **Class 2** Somewhat higher-power (typically up to 24 dBm of radiated power), perhaps to support longer range or more users (say 8-16). Support closed or open access. May be installed by the end-user or the operator. May be viewed as an evolution of picocell technology. Could be applicable for enterprise or indoor hotspot applications.
- **Class 3** Still higher power for longer range or more users e.g. 16 or greater. Typically professionally deployed and may well be open access. Could be deployed indoors (e.g. in public buildings) for localised capacity, outdoors in built-up areas to deliver distributed capacity or in rural areas for specific coverage needs.

2) Standards and specifications

a) What standards and/or specifications are your group currently involved in that pertains directly to femtocells (or equivalent)?

Femto Forum does not publish standards, nor does it create specifications. However we act as market representation partners to 3GPP, 3GPP2 and WiMAX Forum, all of

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<sup>1</sup> Effective Isotropic Radiated Power - EIRP

which are specifying various forms of femtocells. We also have a cooperation agreement with Broadband Forum which is specifying management protocols for femtocells, starting with WCDMA.

b) What is the status and timeline for finalization of these specifications and/or standards?
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The standards / specification organisations should be consulted for details, but a summary of status is provided below. It is notable that all of the major mobile specification organisations have foreseen, based on market demand, the need for femtocells to support future mobile services and have worked actively to progress specifications in a short time period.

### 3GPP Femtocell Specification

- 3GPP has specified WCDMA femtocells (known as *Home NodeB* as a logical network node and *HomeBS* for its RF specifications) in its release 8 specification and has included initial support for LTE femtocells (known as *Home eNodeB*). This was functionally frozen in December 2008 and some remaining elements of the specification were finalised in March 2009 and June 2009.
- 3GPP is continuing to develop these specifications into its Release 9, expected to be functionally frozen in December 2009.
- 3GPP is additionally studying the potential for specifying TD-SCDMA femtocells.

### 3GPP2 Femtocell Specification

- 3GPP2 published requirements for CDMA-based femtocells in May 2008. The requirements envisage development of specifications in two phases:
  - Phase 1: Support for residential use for legacy mobiles and femto-macro mobility, assuming the same radio interface for the femto and macro layers.
  - Phase 2: Enhancements (including new femto-aware mobiles) to permit femto-femto mobility, mobility between dissimilar radio interfaces and possibly enhancements to permit denser femtocell deployments.
- Phase 1 is expected to be completed in mid-2009.

### WiMAX Forum Femtocell Specification

- WiMAX Forum has created a set of detailed requirements for WiMAX femtocells. Again two phases are envisaged:
  - Phase 1: Basic femtocell with limited network features and no change in the underlying air interface and system profile. No change will be required to the

underlying IEEE standards. Support for WiMAX Release 1 (IEEE 802.16e-2005) and Release 2 (IEEE 802.16 Rev2).

- Phase 2: Full femtocell function with advanced network features and air interface optimisation, which will include PHY and MAC layer enhancements in the IEEE 802.16m standard. The system requirements definition document for IEEE 802.16m already includes explicit support for femtocells.

- Phase 1 is expected to be available in the next WiMAX Release 3 (4Q09).
- Phase 2 is expected to be available in WiMAX Release 4 (4Q10).

3) Describe the network architectures being considered.

3GPP has specified in Release 8 a Radio Access Network-based architecture which includes much of the conventional Radio Network Controller functionality within the femtocell and adapts the protocols and interfaces to be suitable for delivery over consumer-grade broadband networks. An IMS-based architecture is under study for Release 9 and beyond.

3GPP2 is specifying an IMS-based architecture in all cases.

WiMAX Forum has not determined the architectural approach but favours a ‘flat’ IP-based approach.

4) What applications for femtocells (or equivalent) are being considered?

Femtocells started as a means of delivering services to residential environments. This remains a core application for femtocells and it enables femtocell technology to be produced in large volumes and low costs. However, femtocells are not limited to this application and early deployments for other purposes are anticipated. Current applications include:

## **Residential**

Femtocells are installed indoors within the home by the end user and may be stand-alone devices or integrated with other technology such as residential gateways. Typically residential deployment supports plug-play functionality. Access to the residential femtocell will often be closed - restricted to a specified group of users – but may also be open to all registered subscribers in some cases. Typically these application needs will be met using class 1 femtocells.

## **Enterprise**

Enterprise femtocell deployments may be in small office-home office situations, in branch offices or in large enterprise buildings. Femtocells for this purpose will typically be class 1 or class 2 and will typically support additional functionality than residential devices such as handover between femtocells, integration with PBX and local call routing. Will primarily be used indoors, but could also be used to serve a corporate campus. Installation will probably be managed by the carrier, but may be achieved by the enterprise itself or its IT subcontractors. Access may be closed, open or hybrid where access is allowed to all registered subscribers in some cases .

## Operator

A wide variety of applications where operators use femtocells to solve specific coverage, capacity or service issues in both indoor and outdoor environments. These could be comprised of class 1, 2 or 3 devices and will likely be open access. They will be installed by the operator or by third parties under the operator's direction.

## Others

These application classes are not exclusive and it is expected that other innovative ideas for the application of femtocells will arise, for example on aircraft or on passenger ferries. In all cases the essential attributes of femtocells described earlier will be observed, enabling full compliance with relevant local customer, operator and regulatory requirements.

- 5) What deployment issues are being discussed – for example:
- a) Security
  - b) handover
  - c) reconfiguration
  - d) discovery and association
  - e) frequency bands and power levels

All of these issues have been matters of study and discussion within the specification organisations and the outcomes are being included within the specifications. Regarding frequency bands, it should be noted that femtocells may be deployed in any existing or new frequency band for mobile services and such flexibility permits the maximum spectrum efficiency benefits to be derived from femtocells, including the use of higher and lower frequency bands with efficient coexistence with other services.

- 6) How are interference issues being addressed?

Femtocell interference management techniques have been extensively studied, both within the specification organisations and within Femto Forum. Femto Forum studied the impact of



femtocells on a mobile network in a wide range of deployment scenarios in order to explore co-existence issues including interference. The study looked at both femtocells using a separate carrier to the surrounding macro network and those using the same carrier – which pose the greatest interference challenge, but also the greatest opportunity for increased spectrum efficiency.

Although femtocells using a separate carrier were demonstrated to provide a simple means to essentially eliminate interference, operators often do not have enough spectrum for this to be practical. The Femto Forum therefore identified technological solutions that mitigate the potential interference where femtocells share the same carrier as the macro network. These methods are already being developed for pre-standard femtocell solutions, and Femto Forum members are working to bring them within the standards framework.

The results of the Femto Forum study have been published and are freely available<sup>2</sup>. The results indicate that, given the use of the right interference management techniques, femtocells can substantially increase the throughput and capacity of a mobile network in a given quantity of spectrum. Additionally, operators remain in control of femtocells at all times, so can avoid instances of interference if they do occur.

As a result of the potential benefits, femtocells have been recognised within the specification bodies as an important element of future mobile networks. Regulatory bodies have also come to this view – for example, the European Radio Spectrum Committee has noted<sup>3</sup>:

“the proliferation of femtocells is supported in the context of more efficient use of spectrum.”

Similarly, the European Regulator’s Group has noted<sup>4</sup>:

“From the operator’s point of view, femtocells enable operators to meet market demand and improve profitability, in terms of: i) better indoor coverage, especially for networks deployed at higher frequencies, ii) better capacity gains, obtained off-loading traffic from the cellular wireless networks, iii) lower backhaul costs, obtained by moving backhaul traffic to locally provided DSL or cable connections, iv) new services, e.g. integrated fixed-mobile bundled services covering voice, data and video.”

Femto Forum is continuing to study interference management issues for OFDMA-based systems, including LTE and WiMAX.

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<sup>2</sup> Femto Forum, *Interference Management in UMTS Femtocells*, December 2008 [http://www.femtoforum.org/femto/Files/File/FF\\_UMTS-Interference\\_Management.pdf](http://www.femtoforum.org/femto/Files/File/FF_UMTS-Interference_Management.pdf)

<sup>3</sup> Radio Spectrum Committee, *Regulatory Aspects of Femtocells*. Brussels: European Commission, 2008. RSCOM(08)40.

<sup>4</sup> European Regulators’ Group, *Report on Fixed-Mobile Convergence: Implications on Competition And Regulatory Aspects*, March 2009, [http://erg.eu.int/doc/publications/2009/erg\\_09\\_06\\_report\\_on\\_fixed\\_mobile\\_convergence.pdf](http://erg.eu.int/doc/publications/2009/erg_09_06_report_on_fixed_mobile_convergence.pdf)