Proposal for Initial Draft of HetNet PAR

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Solicitation of Input Contribution for HetNet SG

Base Contribution:

N/A

Purpose:

This contribution is prepared with a hope to provide a baseline for discussion on HetNet PAR

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Proposal for Initial Draft of HetNet PAR

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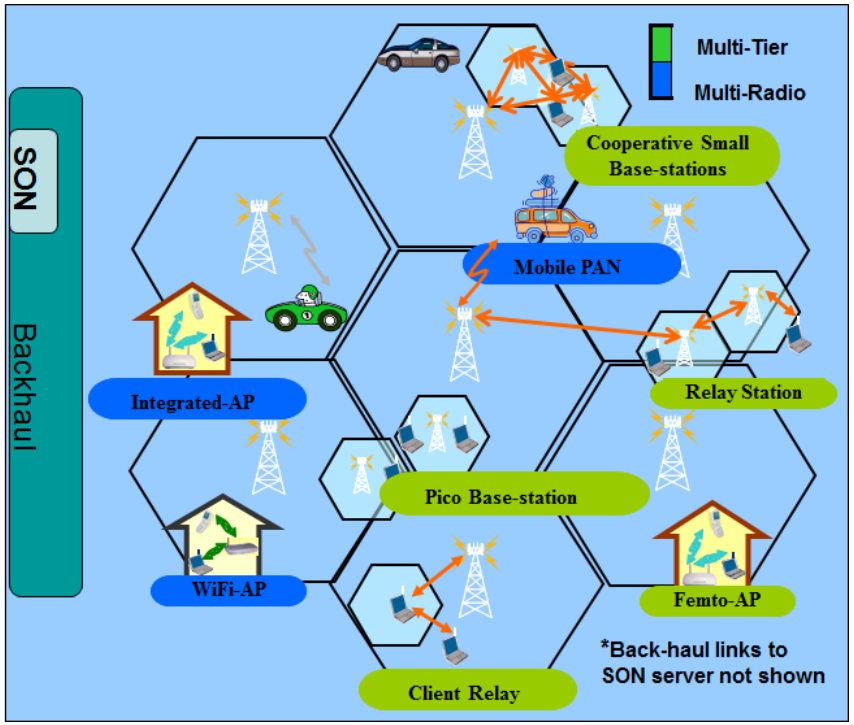
Introduction

- Hierarchical Networks (HetNet) have been studied and discussed in many papers and standard organizations
  - Enhanced interference mitigation
  - Increased system capacity
  - Efficient spectrum utilization & load balancing



- Two implementation scenarios
  - Multi-tier deployment
  - Multi-RAT deployment

- Different views on the implementation & standardization of HetNet

Activities in 3GPP

- HetNet has been discussed as Working Items of Rel-11

- Focused on multi-tier deployment only
  - Heterogeneous Networks defined in TR32.835
    "*Heterogeneous Network is a collective term for a network comprising radio interface of varying sizes and roles, from small base station nodes to big macro stations nodes*"

- Key Technologies for HetNet
  - Enhanced Inter-cell interference coordination (eICIC)
    - Cell Ranging expansion, mobility management
    - Carrier aggregation under multi-carrier deployment
    - Co-channel deployment
  - CoMP enhancement
    - Joint processing, cooperative beamforming, cooperative silencing

Activities in IEEE 802.16

- HetNet has been discussed since July 2010
  - Technologies and requirement for Hierarchical networks (HN) have been discussed in PPC (Project Planning Committee)
  - Summarized in 'HN Study Report' (IEEE 802.16-12-0136-00-Gdoc)

- Scope of HN Study Report
  - Multi-tier deployment of WirelessMAN radio interface
  - Multi-RAT deployment
    - Focused on 802.16-802.11 interworking

- Key Technologies for HetNet
  - Multi-cell coordination for enhanced interference mitigation & cell capacity
  - Intelligent client cooperation for capacity improvement & connectivity for the client
  - Efficient management of cooperative small cells
  - Tightly coupled BS-AP interworking for reduced deployment cost & enhanced spectrum utilization and cell capacity

WirelessMAN Radio Interface in HetNet

- Ready for new project on HetNet
  - Sufficient discussion on HetNet in PPC
    - Deployment scenarios, key technologies, requirements, standard impacts, etc
- Needs more discussion on the strategy or scope
  - Will the new TG deal with multi-tier and multi-RAT deployment scenarios together?
    - Is support of multi-RAT deployment in scope of IEEE 802.16 WG?
    - Protocol Layers above PHY/MAC layer haven't been in scope of IEEE 802.16
  - Different approaches to each type of deployment are preferred
    - Multi-Tier deployment
      - Create a new TG within 802.16 WG because it's definitely in scope of 16 WG
    - Multi-RAT deployment
      - Different scenarios depending on what kinds of RAT and which protocol layers need to be enhanced (new TG or WG?)
      - Needs more discussion on the scope of multi-RAT support

A New Project for Heterogeneous Network

- Proposal for Creation of a New TG to support efficient multi-tier deployment in HetNet
  - Definition of Heterogeneous Network
    - A network comprising WirelessMAN (Advanced) radio interface of varying sizes and roles
    - Macro BS, Pico BS, Femto BS (OSG & CSG), etc
- Scope of the New Project
  - PHY/MAC Enhancement
    - Advanced Interference mitigation based on inter-BS coordination
    - Advanced data transmission based on inter-BS cooperation
    - Advanced mobility management in multi-tier deployment
    - Enhanced BS power management
  - Control and management primitives for efficient inter-BS cooperation
    - Primitives exposed via SAP between 802.16 management plane and network control and management system (NCMS)
      - Refer to appendix in this contribution or IEEE Std. 802.16g-2007 for more information on primitives and NCMS

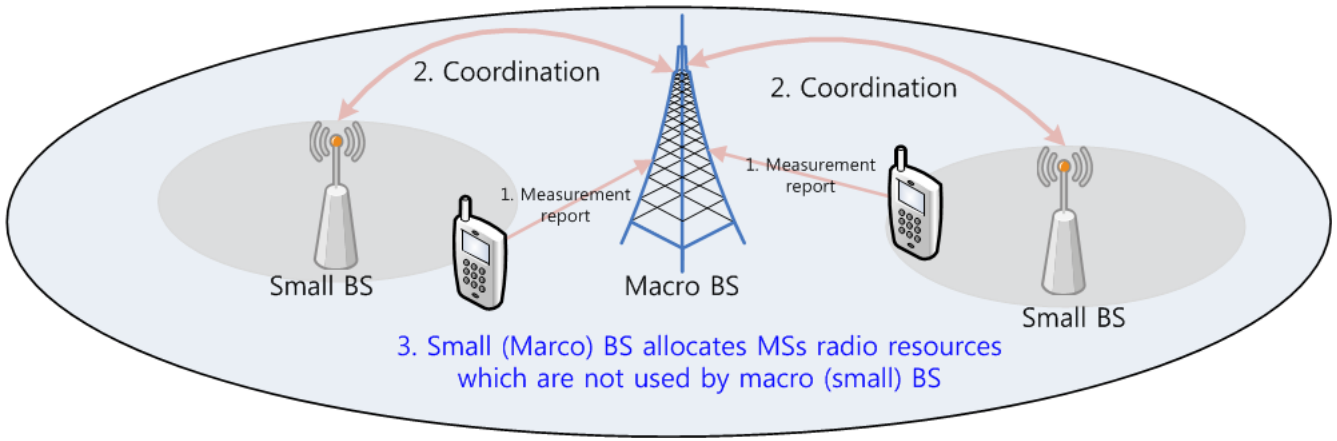
Initial Draft of HetNet PAR

- Title
  - *IEEE Standard for Air Interface for Broadband Wireless Access Systems – Amendment: Enhancements to Support Heterogeneous Networks*
- Timeline
  - PAR approval: July 2012
  - Initial sponsor ballot: Mar 2014
  - Submittal to RevCom: Dec 2014
- Purpose
  - This amendment describes enhancement to enable cost-effective maximization of system capacity, user quality of service and efficient spectrum utilization in heterogeneous networks, and to enable interoperable and efficient management of radio resources, mobility, and spectrum.
- Scope
  - This amendment specifies IEEE Std 802.16 medium access control (MAC) enhancements and minimal orthogonal frequency division multiple access (OFDMA) physical layer (PHY) modifications to enable efficient inter-BS coordination for interference mitigation, mobility management and power management of BS. Standardized primitives for procedures and interfaces to manage conformant 802.16 devices are also included

APPENDIX
Candidate Technologies for HetNet TG

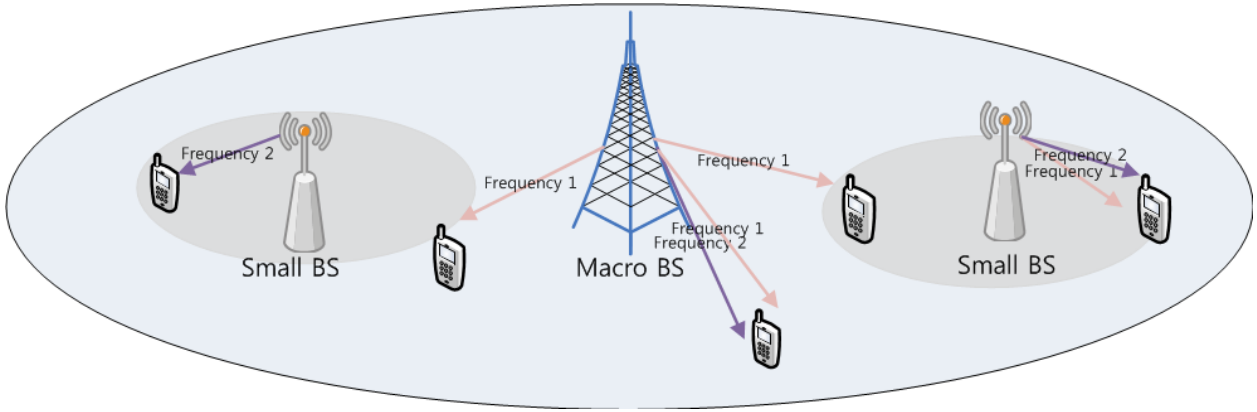
Candidate Technologies for HetNet TG

- Advanced Interference Mitigation (Single Carrier)
  - Key Features
    - A single carrier is shared by macro BSs and small BSs (pico & femto)
    - Coordination between macro BS and small BSs on resource allocation
    - A small(macro) BS assign MSs radio resources which are not used by macro (small) BSs
    - Efficient and effective coordination b/w macro BS and small BS is required (in units of frame or superframe)
    - Efficient measurement report on resources to be coordinated is required
  - Standards Implication
    - Coordination on radio resource (resource allocation & reservation)
    - DL measurement/report



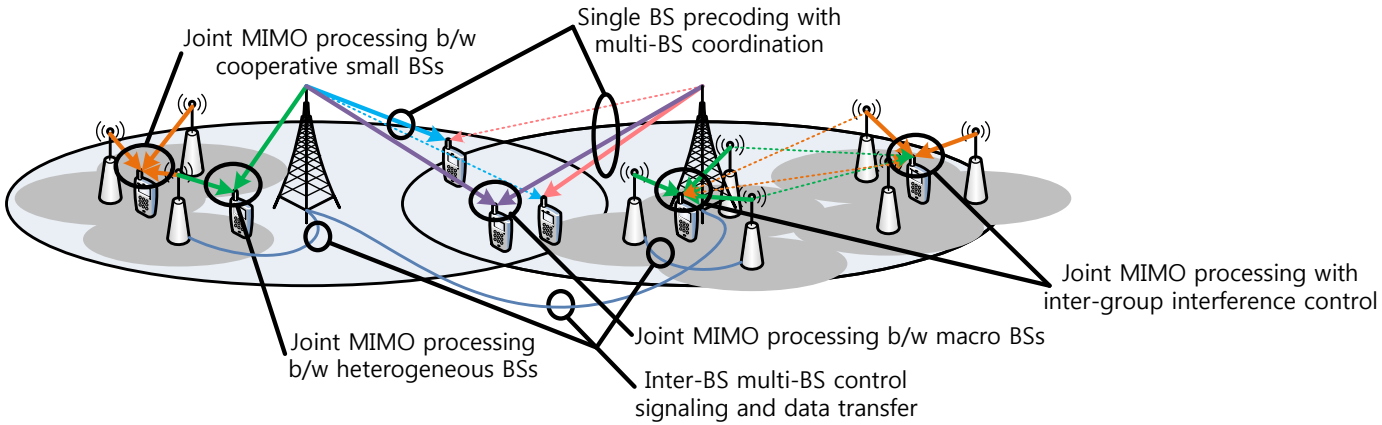
Candidate Technologies for HetNet TG

- Advanced Interference Mitigation (Multiple Carrier)
  - Key Features
    - One carrier is dedicated for macro BSs and another carrier is shared by macro BS and small BSs
    - Carrier aggregation of the secondary carrier is possible
    - Coordination between macro BS and small BS and measurement report on the secondary carrier is required to enable carrier aggregation
  - Standards Implication
    - Coordinated resource allocation
    - Enhanced carrier aggregation in multi-tier system



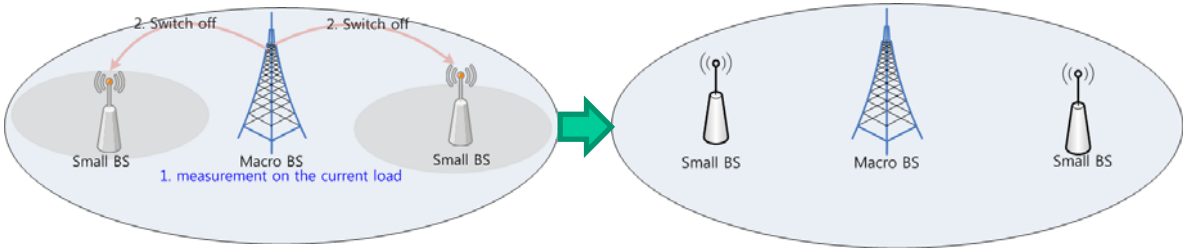
Candidate Technologies for HetNet TG

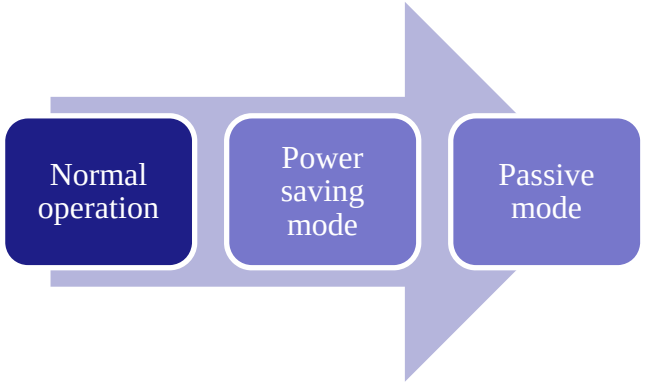
- Multi-BS MIMO Enhancement
  - Key Features
    - Multi-BS MIMO enhancement to support cooperation among heterogeneous BSs and among cooperative small BSs
      - For further improvement of sector and cell-edge throughput
    - Inter-group interference control
      - Interference control between adjacent groups consisting of several cooperative BSs which participate in multi-BS MIMO operation
  - Standards Implication
    - Resource coordination b/w intra-group-BSs and/or b/w inter-group-BSs
    - Efficient multi-BS control signaling and data transfer to support multi-BS MIMO



Candidate Technologies for HetNet TG

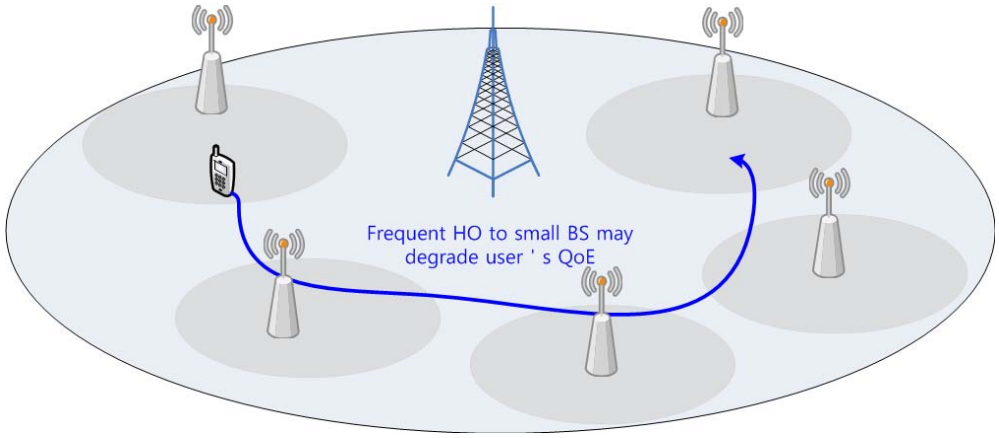
- Energy Saving Mode of Base Station
  - Key Features
    - Macro BS may control the activation of neighbor small BSs depending on user density and traffic load
    - Dynamic traffic-aware power management scheme
      - BS changes its power saving mode according to traffic load by itself
      - In passive mode, BS has to be able to detect a arrival of mobile station
  - Standards Implication
    - Cooperation between macro BSs and small BSs
    - Enhancement of low duty mode defined in 16m
    - A new BS operational mode; passive mode





Candidate Technologies for HetNet TG

- Advanced Mobility Management in Multi-tier Deployment
  - Key Features
    - Seamless and robust mobility of user from macro to small BS, and vice versa, should be supported
      - Improved small cell discovery and identification
      - In case of user with high mobility, frequent HO to small BSs should be prevented while connectivity to macro BS is maintained
      - Considered together with coordinated interference mitigation scheme
  - Standards Implication
    - Neighbor cell discovery and identification
    - HO support with interference mitigation



Candidate Technologies for HetNet TG

- Network Control & Management Interface
  - Not in scope of 802.16 WG
  - However, 802.16 standard can provide a guideline by abstracting network control & management interface as done in 802.16g-2007 standard
- Network Control & Management System (NCMS) in 802.16g-2007
  - Abstract entity consisted of different functional entities
  - May be centrally located or distributed across the network
  - NCMS protocols are not defined in 16g standard
  - Protocol primitives which contains information elements and are exposed via C-SAP & M-SAP
  - This includes MAC and PHY layer context information used to manage and control the air interface