BWA in India and CEWT+BWCI Activities

Prof. Bhaskar Ramamurthi

Hon. Director

Centre of Excellence in Wireless Technology

A Brief Description of CEWiT

- Since 2005
- Located in IITM Research Park
- ~30 staff (30% Ph.D, 10% deep industry exp., everyone ≥ M.S.)
- Supported by DIT (67%) and industry (33%)
- Current focus is on BWA standards
  - LTE-A (till 2010, also 802.16m)
  - Indian operator requirements
- 4G Test Bed development at IITM
  - With industry collaborators
  - SDR implementation, connected to Computer Centre on fiber
  - 3 BTS sites, 8 CPE sites
  - Basic Core Network functions like MME (without handovers)

What's different about BWA in India?

- Limited Spectrum per operator
  - Only 20 MHz
  - Re-use 1:1 is a necessity
- Competitive Service Environment
  - DSL is the price benchmark
- BWA will be primary broadband access for most
  - high system capacity with small cells needed
- Network
  - Urban cell sizes typically 200-500 meters
    - Interference serious issue with1:1 reuse
  - Large fraction of nomadic indoor users
    - ~ 80%

4G vs 2G/3G rollout in India

- 2G/3G mature when rolled out…
  - Device prices on downward spiral
  - Infrastructure also commoditised
- While, 4G TDD technologies relatively nascent
  - LTE still in the works
    - Will have a global ecosystem, but
    - TDLTE evolution / global footprint slower to evolve
- India will be first big market to deploy TDD 4G in 1:1 reuse
  - Will be guinea-pigs for the first time
  - Indian operators technology choices will influence ecosystem
  - Indian operators will need to drive technology trajectory, devices

Common Characteristics of all Broadband Wireless Technologies

CEWiT INDIA

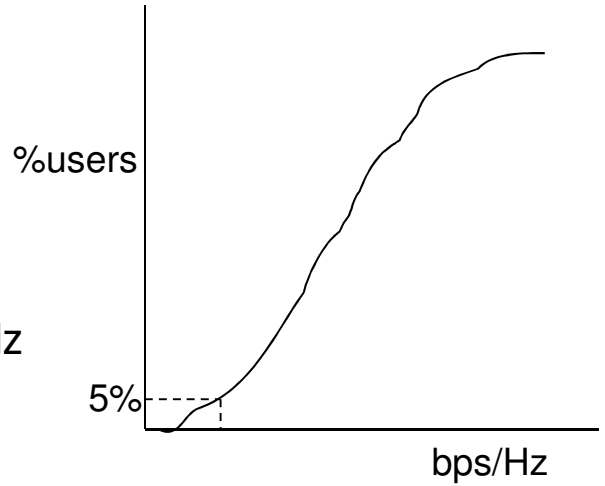
- User data rate varies with distance from BS and cell boundaries
  - Signal-to-Interference+Noise Ratio (SINR) is what matters
  - SINR drops with distance from BS
  - SINR poor at cell boundaries (defined by relative strengths of signals from adjacent BSs)
- SINR variation from -5 dB to 20+ dB
  - Short-term fading makes it negative!
- Question: what data rate to give each user?
  - "High SINR users take all" gives highest cell capacity
    - Low SINR users in outage!
  - "Equal data rate to all" : "wireless DSL"
    - Low SINR users need a lot of bandwidth : lowest cell capacity
  - "Proportionate Fair (PF)" scheduler : compromise
    - Does India also use this, or some adapted version?

SLAs: the Scheduler is the "Brain"

- SLAs to be ensured for different subscriber classes
  - Enterprise
  - Premium
  - Common man
- SLA may involve guaranteed QoS for different traffic classes
  - Streaming (Youtube, IPTV, etc)
  - Browsing
  - Downloads
- To implements the SLAs, Operators will need to get deep into the scheduler
  - But it is buried in Layer 2 on embedded processor, and functions in millisec time-scale

Spectral efficiency numbers/curves

- Mean cell Spectral efficiency : bps/Hz/cell
  - Here, "cell" means sector
  - If spectrum reuse is not 1:1, the reuse factor is taken into account
    - by dividing the cell throughput by the reuse factor
- User spectral efficiency (bps/Hz)
  - A cumulative distribution function (cdf)
    - X axis : bps/Hz
    - Y axis : fraction of users with SE less than X bps/Hz
- User S.E. curve depends on type of scheduler
  - PF scheduler usually assumed
- To get a simple number, user S.E. of bottom 5% is quoted
  - i.e., only 5% of users have S.E. below this number



CEWiT's focus in standards

- Small cells, 1:1 reuse, low SINR users
  - Improve performance of low-SINR users
- Improving cell S.E., particularly with 1:1 reuse
- Heterogenous networks (pico cells, relays) important in India
  - To increase S.E. by multiples
    - MIMO, etc cannot give such large increases
  - But, pico cells have to be deployable in ad hoc self-organizing manner
    - as fiber goes into macro cells to serve enterprises
- Improving performance of indoor users
  - Femto base stations not an important solution for India
  - We need "wireless femtos", or indoor relays
  - But, these must be user self-installed

CEWiT's contributions to 802.16m

- CEWiT got into the act around the start of 16m standardization
- 16m started on a clean slate
  - 16e backward compatibility achieved by time-zoning
- Got key IPRs incorporated in standard for first time
  - A transmission mode with specific pilot structure that enables receivers to maximally cancel interference (Open Loop Region, CoFIP)
  - An improvement of simple data repetition for improving cell edge performance (conjugate data repetition)
- IITB also had contributions in Layer 2
- CoFIP now being actively considered for Inter-Cell Interference Cancellation in LTEA Rel 11

Pressing issues with Rel 9

- What will different users in various locations experience?
  - Question valid for all BWA technologies
- If we have a 3D (or 2.5D) map, can we simulate the scenario?

- If there are coverage holes in a skyscraper-zone, how do we plug them?
  - Can we employ relays, although Rel 9 does not support?

- Even if multiple operators synchronize the 5 ms frames, can they use different UL/DL ratios?
  - At least among 50:50, 60:40
  - What about same operator using different ratios in different cells?

Simulation to reduce uncertainty

- CEWiT has a complete 19-cell, 57-sector, LTE Rel 9/10 simulator called BWSim
  - Fully calibrated and tested against simulators of major vendors
  - Both DL and UL
  - Has in-built 3GPP channel models
  - Was used in ITU's IMTA study
- We can link it to a 3rd-party propagation tool
  - E.g., a 3D ray-tracing tool
  - Need API to transfer the channels from each eNB to each terminal
    - in each subframe
    - BWSim can simulate the LTE system for the channels
- It is possible to simulate the performance for specific locations in an actual deployment

Relays

- In order to tunnel S1 interface to relay, eNB must support S1 tunneling
  - This is a Rel10 software feature
  - Vendor must support this feature at least in a Rel 9 eNB
- Rel 9 UEs cannot work without CRS in every subframe
  - So relay must trasmit CRS in all subframes
  - This means relay must be full duplex
- It is possible to design a relay which can
  - Work with Rel 9 UEs
  - Work with Rel9+ eNB (with the limited Rel 10 tunneling feature)
  - Which can be transformed to a micro eNB if backhaul reaches relay location

TDD Co-existence

- It is possible to use smart scheduling techniques to
  - Enable adjacent cells of one operator to have different UL/DL ratios
  - Enable two operators on adjacent spectrum slots to have different Ul/DL ratios
- This is a study item in Rel 11
  - CEWiT is contributing significantly for addressing Indian requirement
  - Focus of other countries on different configs in multi-carrier mode
- CEWiT can work on making it possible with Rel 9
  - Will require some software support on UE for a couple of additional control messages
  - And, modifications in eNB scheduler
- Indian operators must demand that Indian requirements are addressed