High density MIMO for beyond IMT-Advanced systems

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LG Electronics

RE:

[STDS-802-16] 802.16 Project Planning Committee: Call for contributions for Study Items and New areas

Base Contribution:

None

Purpose:

For discussion in the Project Planning Committee

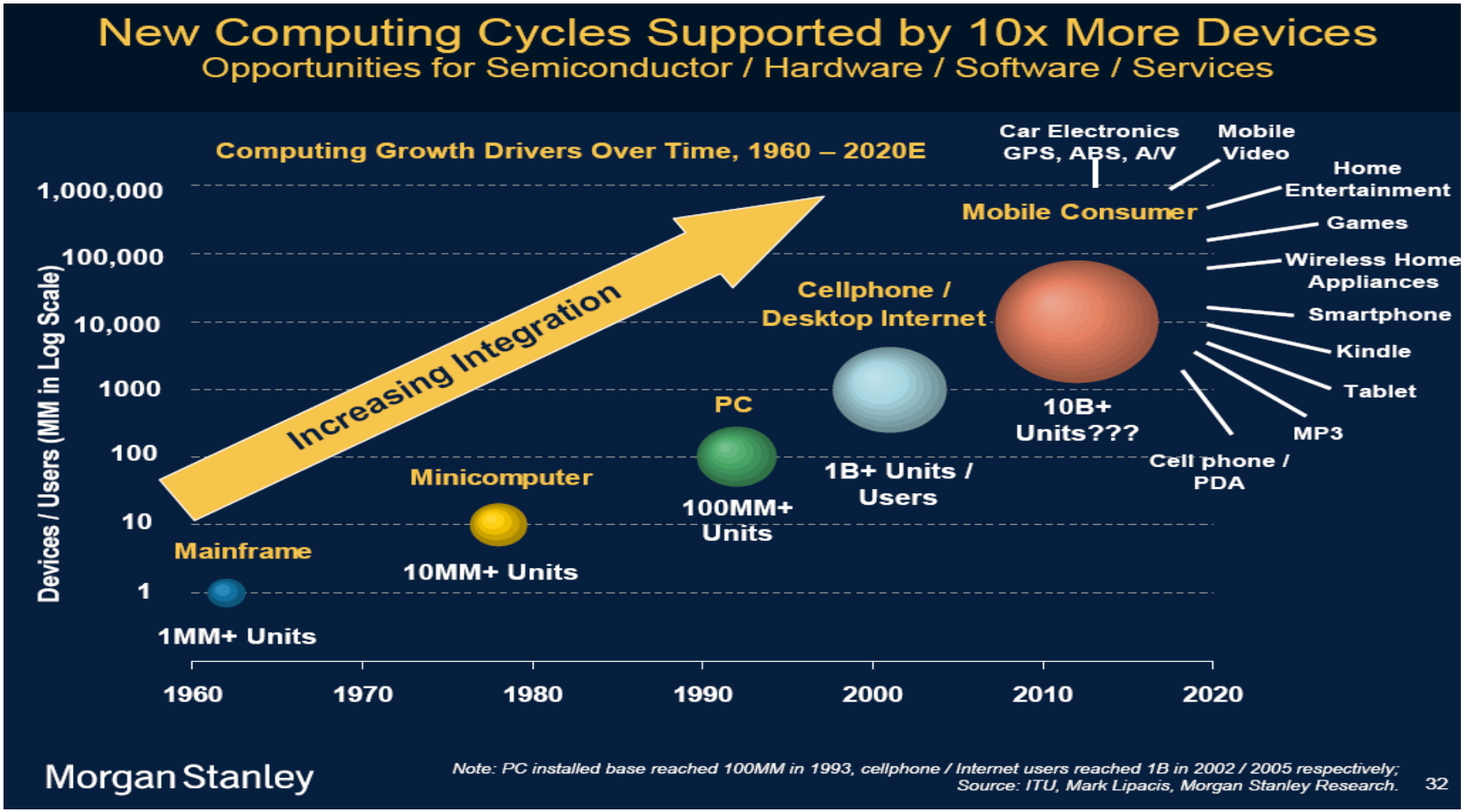
Agenda

- Requirements for beyond IMT-ADV systems
- Technologies for requirements
- Conclusions

Requirements for beyond IMT-ADV systems

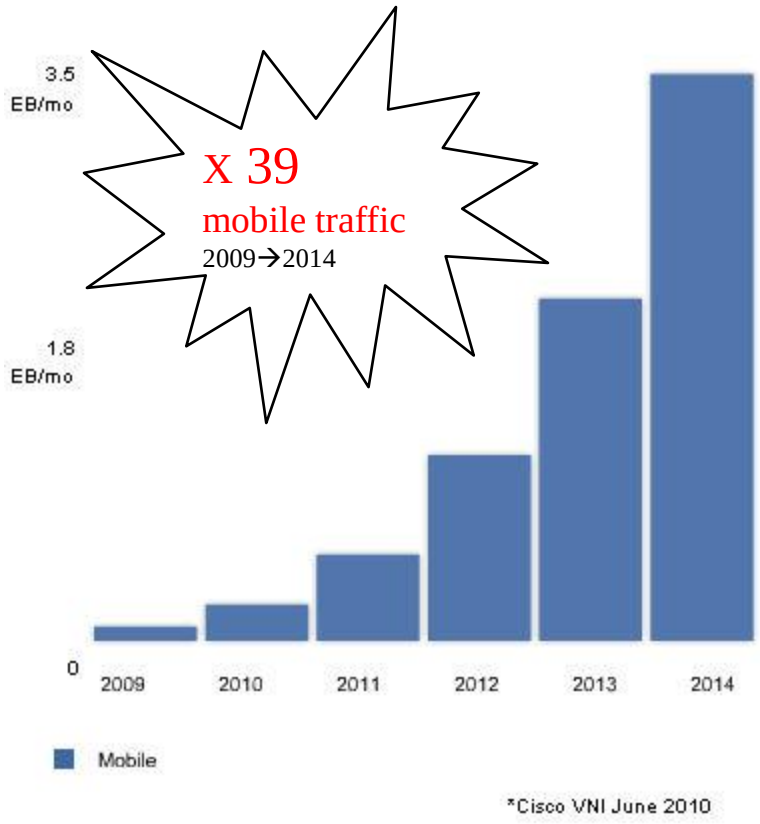
Evolution of mobile communications

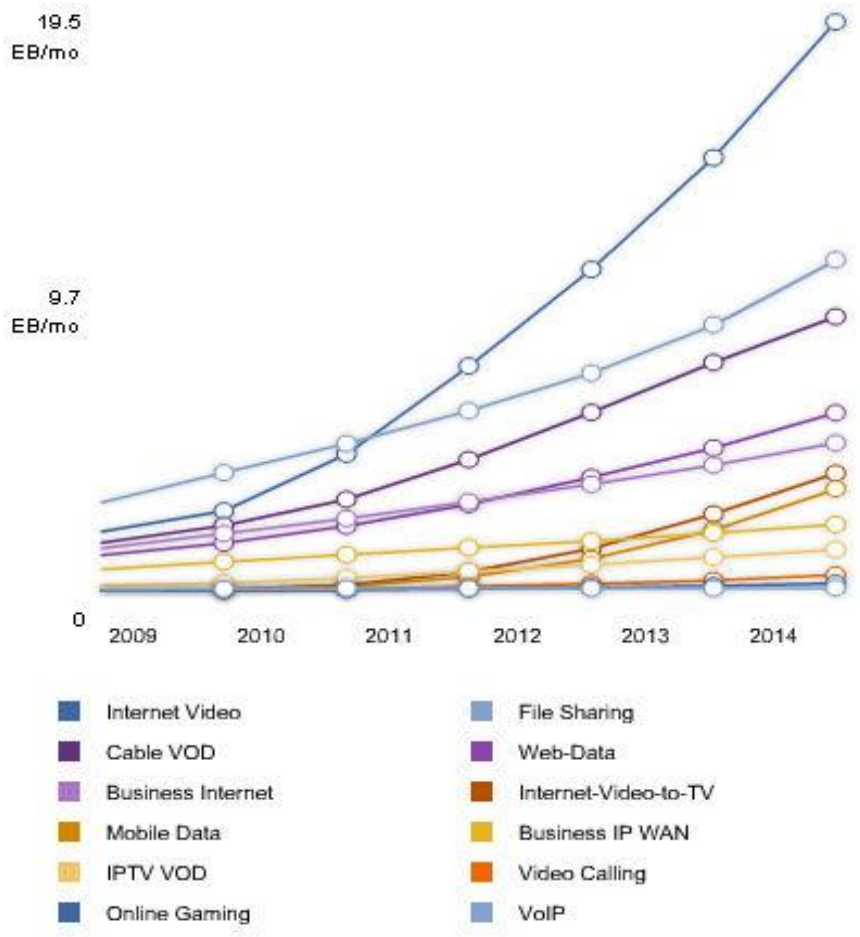
- Device population explosion



Evolution of mobile communications

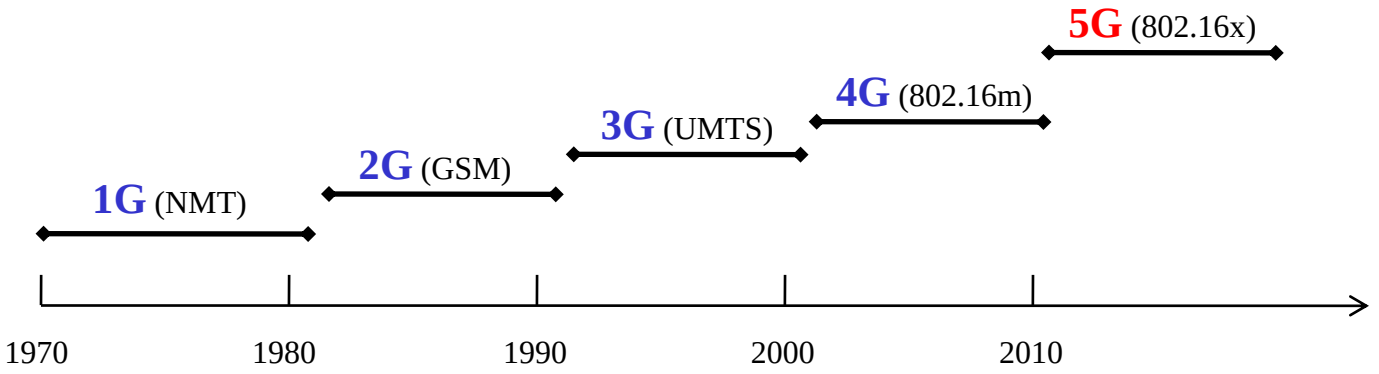
- Fast increasing data traffic, especially for mobile devices





Implications

- Ultra high capacity network required
  - Mass devices for various applications (x10 more)
  - High data rate service requested such as multimedia messaging
  - Increasing demands for high data rate communications anytime anywhere
- Time to initiate 5G
  - Generations of wireless communication standards
    - Approx. 10 yrs from the start of the R&D project to the appearance of the mobile generation [Wikipedia: 5G] → 5G shall be initiated in 2011.



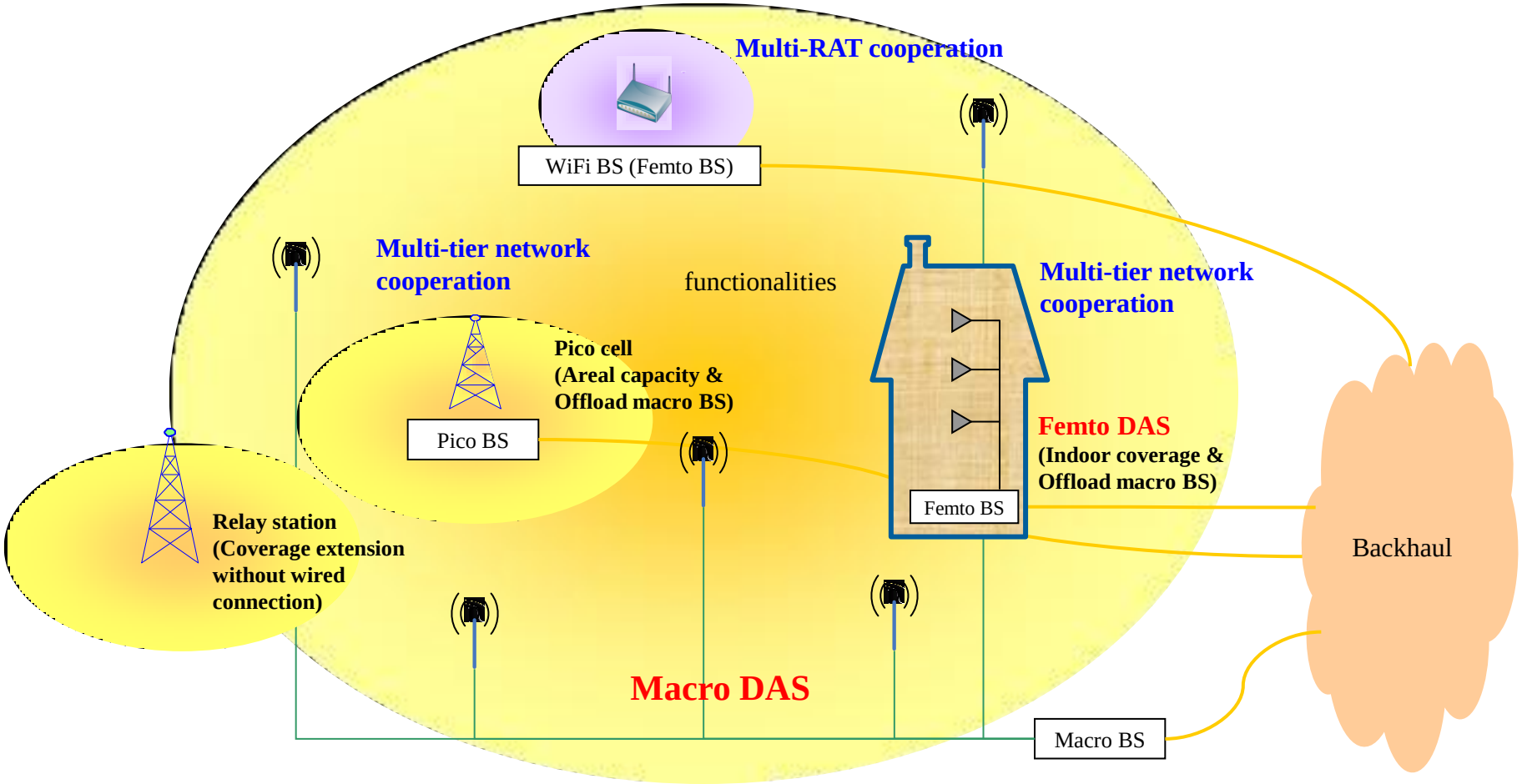
Technologies for Requirements

Promising Solutions

- Small base stations: Off-loading macro-BS with small BSs such as pico/femto BSs
  - Multi-tier cooperation on a single RAT or Multi-RAT cooperation should be applied for reducing inter-cell/BS interferences, increasing throughput, and simplifying the handover process.

- Distributed antennas: Enhancing the link/cell/network capacity
  - Distributed antenna system (DAS) increases cell capacity over the conventional centralized antenna system (CAS) in both uplink & downlink.
    - In an experiment, DAS achieves 3x throughput than CAS [C802.16-10/0018].
    - In practice, DAS can easily extend its number of antennas so that the capacity gap can be increased further.

Vision of advanced network



High Density MIMO

- Given area, the advanced network has larger number of antenna than the conventional network in order to achieve ultra high capacity anywhere, which means a network of high density MIMO (HD-MIMO).

- Beyond conventional MIMO
  - Operation with numerous antenna within area regardless of cell or sector
  - Examples
    - Multi-tier/Multi-RAT Network
    - Distributed Antenna System (or Remote Radio Head)
    - Multi-BS Cooperation

Technologies for HD-MIMO

◆ Advanced Multi-BS cooperation

- Types of multi-BS cooperation
  - Multi-RAT cooperation
    - E.g.) Cooperation of WiMAX and Wi-Fi BSs
  - Multi-tier cooperation on a single RAT
    - Overlaid multiple tiers of cells, macro/micro/femto/pico, sharing common spectrum
    - Gains in areal capacity via aggressive spectrum reuse
    - User installed BS as well as operator installed BS
- How to cooperate?
  - PHY level: Multi-BS MIMO transmission & reception
    - Single BS precoding with multi-BS coordination, Multi-BS joint processing
    - Basic functionalities included in IEEE 802.16m
  - MAC level: Network entry, handover, ranging, etc.
    - Basic functionalities included in IEEE 802.16m
- With sufficient backhaul capacity, more advanced multi-BS cooperation techniques can be applied in the future.

Technologies for HD-MIMO

Operation in DAS

- Traditional MIMO scheme has been based on the centralized antenna system → Move to MIMO with distributed antenna or BS
- DAS facilitates the multi-BS MIMO cooperation thanks to the enhanced backhaul [Appendix]
- MIMO with distributed nodes
  - Node: Antenna node in DAS or BS in multi-tier/-RAT network
  - Techniques
    - Node selection
    - MIMO communications with partial BS antennas
    - Per-node power control
    - Interference mitigation

Conclusions

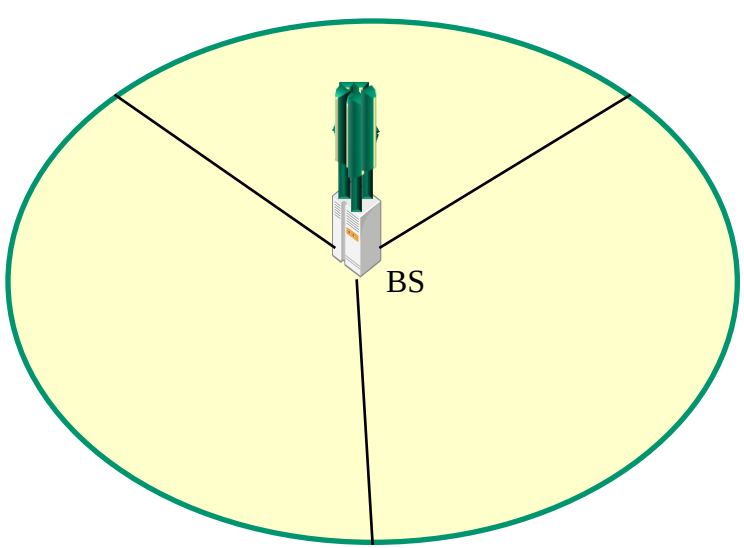
- Advanced network for ultra high data rate
  - Higher density of antenna within area of interest
    - Overlaid network offloading macro-BS with small BSs
    - Distributed BS antennas and/or small BSs all over the cell
  - Key technologies of each mobile generation
    - 2G(CDMA)→3G(OFDMA)→4G(MIMO)→5G(HD-MIMO)

- Recommendations
  - Technologies for Beyond IMT-A and IEEE 802.16m system should be developed based on the HD-MIMO.

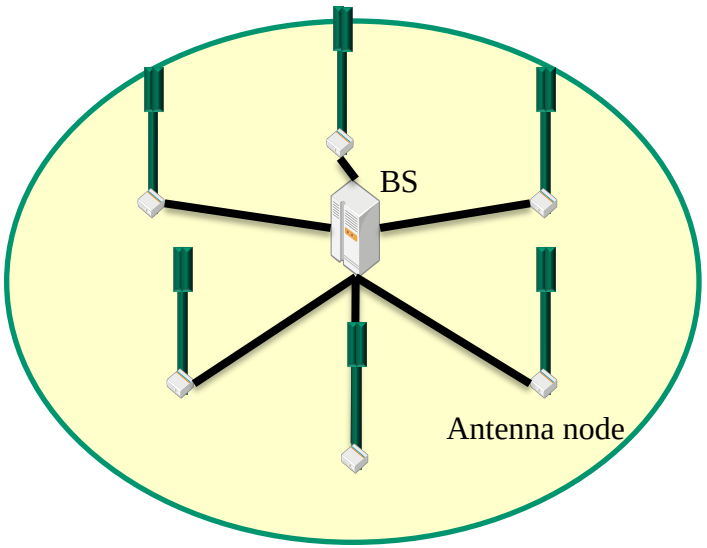
Appendix-Distributed Antenna System (DAS)

- Definition
  - A network of spatially separated antennas called “nodes” connected to a common source via a transport medium that provides wireless service within a geographic area or structure [wikipedia.com]
- Once deployed, multiple-airlink/frequency/WSP* can be supported.
  - Remote Radio Head (RRH) supporting single airlink/frequency/WSP* has evolved into antenna node in DAS.

*WSP:Wireless Service Provider



Centralized Antenna System (CAS)



Distributed Antenna System (DAS)

Appendix-Architectural benefits of DAS

- In DAS, the RF is taken from a base station and moved to distributed locations.
  → Radio resources can be placed in a single location.
  - Minimizing real estate
  - Simplifying management & maintenance
  - Smart solution overcoming the lack of backhaul capacity between cell cites and mobile switching center (MSC) for the growing traffic
  - Thanks to the increased backhaul capacity, DAS can facilitate advanced multi-BS cooperation techniques such as network MIMO techniques.

Traditional RAN Architecture
(Three Sector Cell Sites)

Small Cell RAN Architecture with BTS Hotel and DAS
(Each Hexagon is a Cell Site)

[Source: ADC]