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LTE-Advanced and MPLS backhauling

LTE-Advanced introduces new key features to mitigate interferences, maximize radio performances and boost user capacity. All of these features have specific requirements that are reflected into the backhauling network. In this paper, we will address these requirements and see how the introduction of MPLS and layer3 microwave radio systems provide the best solution for backhaul of these new features.

SM€ siae microelettronica

Whitepaper – April 2017

Introduction

LTE-Advanced is becoming a reality in many deployed networks. Its primary objective is to maximise radio access performances by introducing a set of techniques that autonomously adjust the radio parameters of each neighbouring cell. This coordination addressing macro to macro, as well as macro to small cell will:

- Boost capacity download to the user
- Maximize spectral efficiency
- Strongly mitigate cell interferences
- Improve network capacity utilization

To accomplish all the above, LTE-Advanced introduces new stringent requirements compared to LTE that are reflected into architectural changes of the backhauling network.

Among other the differentiating functionalities introduced by LTE-advanced are:

- Carrier Aggregation (CA)
- Enhanced Inter cell Interference Coordination (eICIC)
- Coordinated Multipoint (CoMP)

On top of these, the X2 signalling, takes a primary role in LTE-Advanced, as these features all require real time information exchange between neighbouring cells. Communication latency because of these become a primary need with a linear impact on network performance.

Carrier Aggregation **(CA)**

Carrier Aggregation is the ability to aggregate multiple radio carriers (up to five) to reach a maximum of 100MHz bandwidth communication to the user device. The strong advantage in LTE-A is the possibility to address non-contiguous carriers. This drastically increases data rate and spectrum utilization, especially in peak data usage. Furthermore, it allows operators holding fragmented spectrum to make the most of these available resources. Often associated to carrier aggregation is the increase of MIMO support, up high order 8x8 in downlink, adding a second level of efficiency: capacity and beam steering.

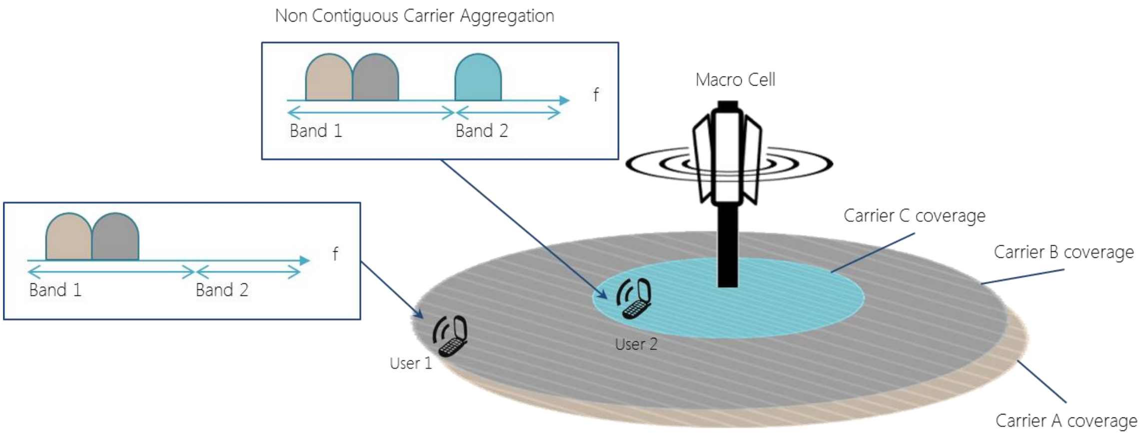

Figure 1: Carrier Aggregation

enhanced Inter cell Interference Coordination **(eICIC)**

ICIC and eICIC introduced with LTE-A target the mitigation of interference to maximise radio access performance. These protocols aim to adjust in real time power settings of transmitting sub-channel, optimizing each transmission to the receiving user position, and consequently reduce the interference to the same sub-channel in a neighbouring cell. This coordination is done in the frequency domain.
If we consider the addition of small cell deployment (including pico, femto, and any other cell within the macro coverage area), the need for coordination is even more important as frequency coordination is no longer sufficient. Coordination must also be considered in the time domain.

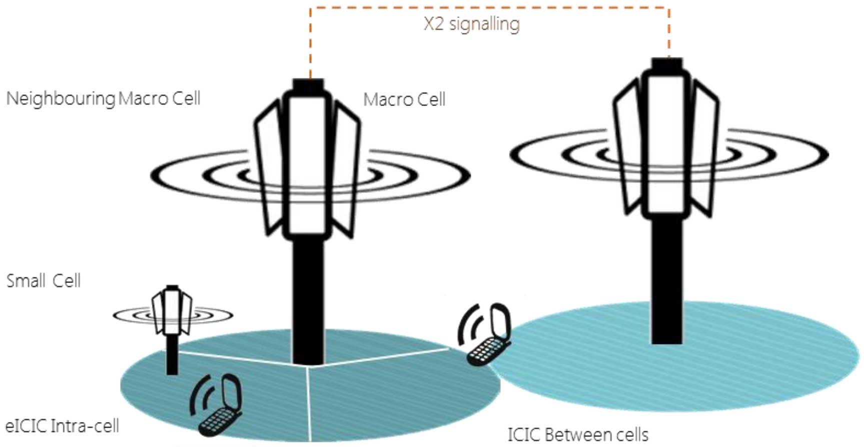

Figure 2: eICIC

Coordinated Multipoint **(CoMP)**

Coordinated Multipoint is a dynamic coordination of transmit and receive signals between multiple neighboring cells to the same user device to maximize radio performance and quality of experience QoE when the user is located at the cell edge. This coordination requires real time adjustments for mobility, consequently the latency in the signaling between cells is paramount.

Once at a cell edge, the received signal of the main macro cell is just as strong as the interference coming from the adjacent cell. In this case QoE is drastically affected. CoMP aims to coordinate the two cells' carriers in a constructive interference, removing therefore any negative interference signal, boosting capacity and enhancing QoE. CoMP relies on the X2 signaling protocol to carry out the coordination with the lowest latency possible. While for LTE NGNM expressed the x2 roundtrip requirement of 10ms, in LTE-A with CoMP the latency of X2 should be brought down to as low as possible figure. A 5ms figure showed to bring a 20% capacity throughput improvement.

LTE-A and backhauling impact

With the introduction of release 10, LTE-Advanced now requires a more sophisticated backhauling infrastructure capable of delivering:

- Synch with phase and time of day
- Higher transport capacity from cell to core
- Higher transport capacity between cells
- More stringent latency requirements for X2 transport

X2 is an LTE interface connecting peer-to-peer eNodeBs to provide a rapid way for the base stations to communicate and coordinate resources for activities like call handover. Today the X2 signalling is transmitted from an eNodeB to the service gateway located in the metro network to be routed back to the access adjacent eNodeB cell. This is possible also thanks to the signalling rate of X2.

X2 capacity is estimated by NGNM to be 4% of S1 interface, equal to Kbps of data. However, with the capacity to the user growing to reach hundreds of megabits or even 1Gbps, the X2 capacity may rise to account for Mbps worth of data. If to this, we sum the low latency requirements, the X2 roundtrip to the service gateway is no longer feasible. The backhaul network needs to enable a low latency solution by locally re-routing the X2 signalling protocol.

MPLS in backhauling

As per today the vast majority of backhauling networks are built using simple Carrier Ethernet transport in the backhauling "cell to pop" network.

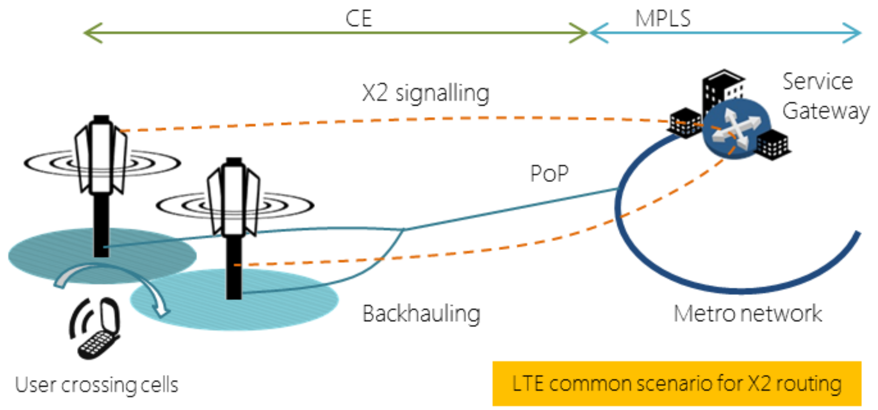

Figure 3: LTE backhauling scenario

Enabling Layer 3 networking in the backhaul would shorten the X2 routing among neighbouring cells at the cell level, reduce the network load of unnecessary traffic to the core network, improve capacity utilization in the backhaul and reduce to a minimum, the X2 latency, improving overall the radio access performance.

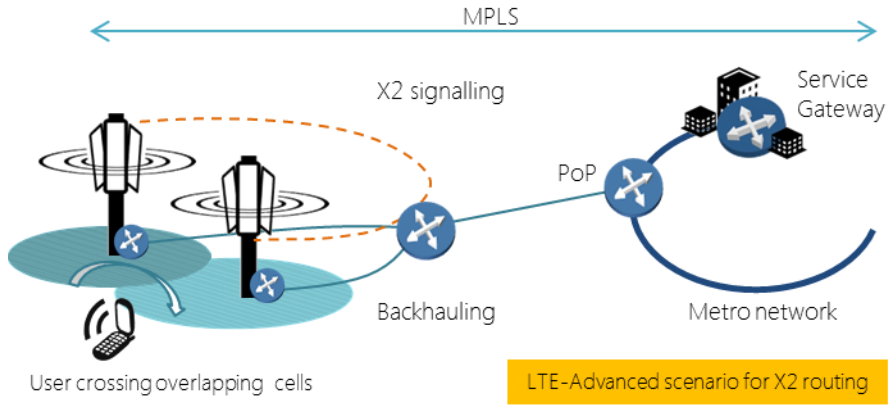

Figure 4: LTE-Advanced backhauling scenario

With the implementation of MPLS, operators would also be in the position of creating more articulated backhauling architecture including rings or mesh/partial mesh, offering a higher level of resiliency and network availability that would prove fundamental in the deployment of future 5G highly reliable network applications.

SIAE MICROELETTRONICA LTE-Advanced backhauling solution

SIAE MICROELETTRONICA has recognized this need of mobile operators to enable LTE-Advanced features, and included in SM-OS, a strong set of functionalities to support the evolution to LTE-Advanced.

MPLS support

The SM-OS, common operating system across the microwave radio portfolio, supports MPLS protocol to create L2VPN and L3VPN services. Furthermore, it supports protocols for transport resiliency. These have been tested by EANTC at their Interoperability Showcase 2017, with major router suppliers.

ITU.T Y.1731 – ETH-BN

Within the EANTC testing, SIAE MICROELETTRONICA's AGS20 split-mount platform was tested in a L2VPN and L3VPN scenario where the AGS20 initiated the IP/MPLS service that was terminated on an existing infrastructure of IP/MPLS aggregation routers in a mutli-vendor scenario. The AGS20 operated both as P and PE router. In the same showcase SIAE MICROELETTRONICA's AGS20 was tested in a resiliency scenario where by degrading the radio link, the traffic was re-routed by the microwave radio toward a secondary path.

Following the collaborative solution developed between SIAE MICROELETTRONICA and CISCO named Microwave Adaptive Bandwidth MAB [read more here], during the showcase we demonstrated the implementation of the ITU.T Y.1731 that now represents the standardization of the MAB protocol within the ITU-T as part of the OAM functions and mechanism for Ethernet based networks.

ITU-T G.8275.1 telecom profile for phase/time synchronization

Support of the synchronization for phase and time as defined by the IUT-T for telecom profile in boundary clock application is a necessity. During the test, it was verified that regardless of the degradation of the radio link and changes of modulation, phase signal was correctly transported across the link in line with ITU-T G.8275.1 performance requirements.

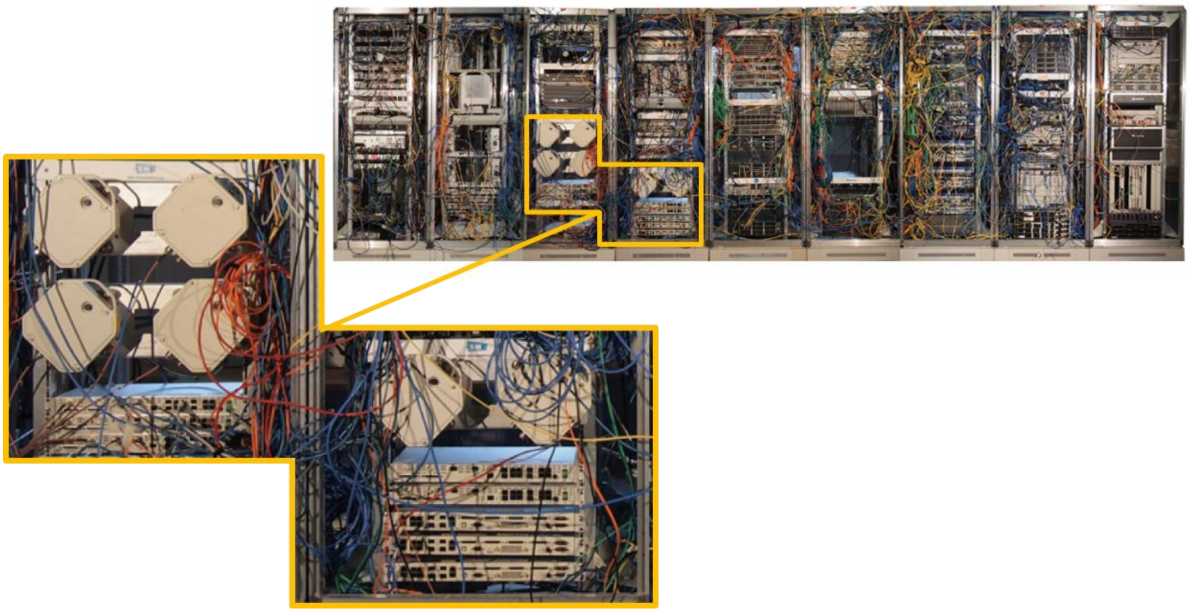

Figure 5: EANTC showcase layout 2017, in highlight the AGS20 links

SIAE MICROELETTRONICA AGS20: a platform for the future

SIAE MICROELETTRONICA's AGS20 split mount microwave radio represents the most flexible platform designed for optimal performance in mobile backhaul applications. Since its release in 2014, its been demonstrated to be future-proof, scaling from a carrier Ethernet platform to an MPLS multi-vendor tested platform in March 2017, with only software upgrades. Operators liaise on existing deployed AGS20 networks to keep launching new RAN features, improving their network performances, without the thought of the backhaul as bottleneck.

Powered by SM-OS, AGS-20 can also support deployment in SDN architectures thanks to embedded NetConf agent and YANG infomodel

[Read more about AGS20]

Contents

Referenced Material

1) Interoperability showcase 2017 whitepaper by Eantc [http://www.eantc.de/fileadmin/eantc/downloads/events/2011-2015/MPLSSDNNFV_2017/EANTC-MPLSSDNNFV2017-WhitePaper-Final_v2.pdf]
2) Guidelines for LTE Backhaul Traffic Estimation by ngnm [https://www.ngmn.org/uploads/media/NGMN_Whitepaper_Guideline_for_LTE_Backhaul_Traffic_Estimation.pdf]

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