Application aware converged access network

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Architecture

OLT

ONU

Fixed clients

Mobile clients
Description about architecture

- PON architecture supports both fixed users and small cells
- NGFI is striving for traffic dependent, packet based fronthaul
- PON can be used as fronthaul for next general packet based fronthaul
- There is need for intelligent resource allocation that takes into account various client needs
- This study focuses on QoE aware resource allocation in LTE (wireless) and also fronthaul bandwidth provisioning based on client demands
- Applications considered are video streaming, video conference since they take up major access resources.

Two level bandwidth dimensioning

- Resources are allocated in wireless domain using application information to maximize the QoE of users
- There algorithms are considered to achieve this
- Skype/Youtube based adaptive streaming is incorporated
- Each profile is made of certain resolution and frames per second
- Each profile is associated with an empirical MoS
- This information is made available at the MAC scheduler (could be centralized or independent) to allocate resources such that overall QoE is improved
- Once the wireless resources are allocated, fronthaul can be dimensioned for traffic/QoE demand
Supporting fronthaul standards

- **Interface II** between QAM+Multi-antenna mapping and Resource mapping by NGMI, can be packetized and traffic dependent
- Next generation fronthaul interface by China mobile is proposed to be Ethernet based
- IEEE workgroup 1903.4 is working on radio over Ethernet
- The proposed scenario also works for full fledged eNodeB's which backhaul the traffic to core network

Next Generation Mobile Networks 5G white paper [https://www.ngmn.org/5g-white-paper.html](https://www.ngmn.org/5g-white-paper.html)
IEEE workgroup 1904.3 on Radio over Ethernet
Skype profile levels

- Skype uses video adaptation based on network state
- Supported resolutions: 19200, 76800, 307200
- Supported frame rates: 5 to 28 fps
- Required data rates: 320 kbps to 27.6 mbps
- MoS is calculated using empirical formula using above parameters
- MoS ranges from 2.9 to 4.7
- Mobile and fixed clients using adaptive streaming applications are classified into 3 types based on minimum acceptable MoS
Resource allocation problem

- Given UE and cell association, client type and channel condition for each UE, find out the resource allocation such that it maximizes overall QoE of the system
- Constraints: total resource blocks, minimum acceptable MoS for each client type
- Objective: Cumulative MoS
- System: LTE 20 MHz, Rayleigh fading channel
### Fading channel TBS assignment

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MCKP - Dynamic Programming Algorithm

- This problem can be modelled as a multiple choice knapsack problem and dynamic programming approach can be used to perform resource allocation.
- For every UE, weights and profits are determined based on their client type and channel condition.
- Weight is the number of resource blocks needed to achieve a certain video rate and hence certain MoS.
- Profit is the incremental MoS achieved by using certain profile level.
- Steps:
  - For every UE, find out channel condition (every TTI), based on which maximum coding rate is calculated.
  - Using this coding rate, find out the acceptable weights and profits for each UE.
  - For every UE, pick one profile level (w,p) such that cumulate MoS is maximized.
Modified Round Robin Algorithm

- Allocate resources such that minimum acceptable profiles are supported for all UE
- Calculate allocated budget based on what ever is allocated
- Choose a random UE number
- Allocate best profile within remaining budget that increases MoS of UE
- Repeat this in a round robin fashion until all the resources are allocated or all UEs are visited
Water-filling algorithm

- Allocate resources such that minimum acceptable profiles are supported for all UE
- Sort the UEs in decreasing channel conditions (coding rate)
- Calculate allocated budget based on what ever is allocated
- Select the UE with maximum coding rate
- Allocate best profile within remaining budget that increases MoS of UE
- Repeat this in a descending order of channel rates until all the resources are allocated or all UEs are visited
Results

- ... still working on them ...
Deliverables

- Results for MCKP algorithm
- Results for bandwidth allocation in fronthaul/backhaul part
- Better model/algorithms?