OPTIMIX

Presentation at the 6th FP7

Networked Media concertation meeting

29/11/10, R.Fracchia

OPTIMIX in few words

- ICT FP7 (Call 1 project) over 3 years
  - » End of the project: 28/02/2011

- Goal: Enhanced video streaming in a point to multi-point context for wireless heterogeneous systems, based on end-to-end cross layer adaptation
  - » WP1: Requirements and exploitation
  - » WP2: Coding and modulation
  - » WP3: Transmission over the network
  - » WP4: System evaluation and demonstration

Partners and roles

- Project Coordinator
- WP2 leader: Coding and modulation
- Integrator of the joint simulator
- Integrator of real-time test-bed

- WP1 leader: dissemination and exploitation
- MPEG standardization
- Realization of H264/SVC real-time codec

- WP3 leader: Transmission over the network

- WP4 leader: Real-time demonstration
- Realization of modified IEEE 802.11n boards

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Why is adaptation needed?

- Multimedia communication can be very bandwidth consuming
- Quality of the wireless communication is time-variable
  - » Varying modulation scheme and thus maximum throughput
  - » Varying loss and bit error rate
- Compression done at the application layer has to be coupled with redundancy inserted for error correction
  - » Need of dynamic selection of coding and protection parameters

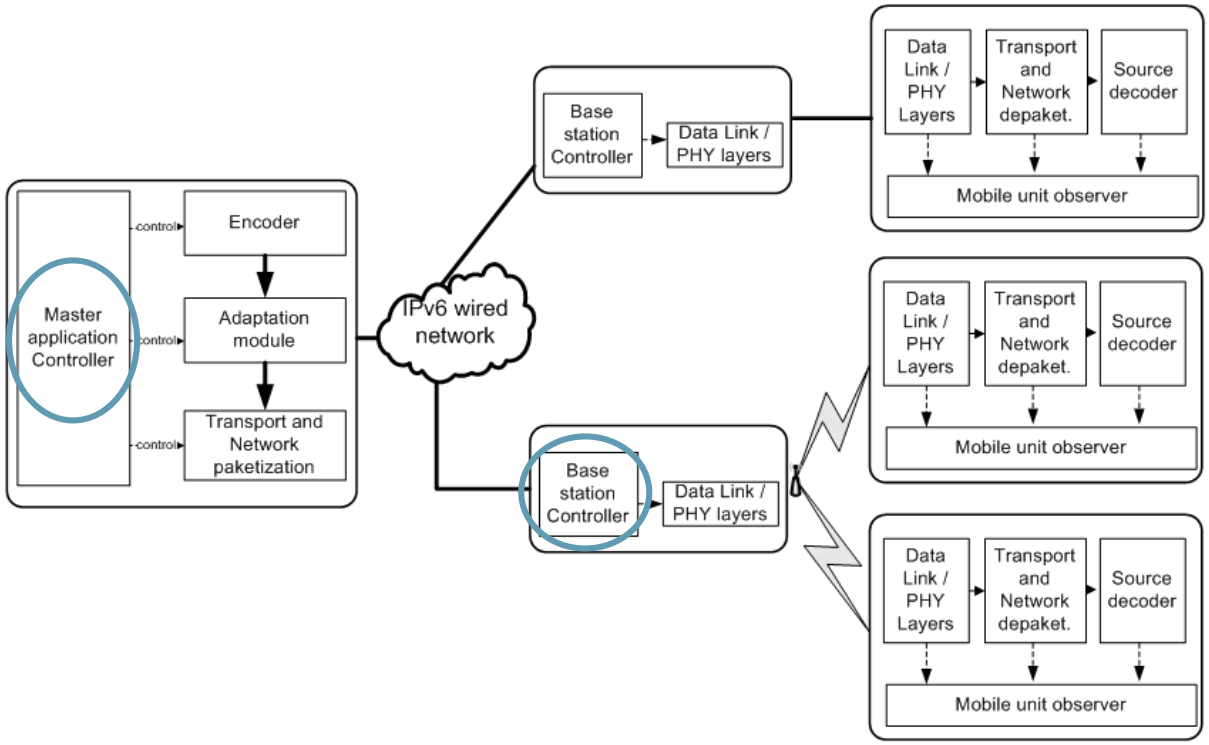
Project approach

- Introduction of two separate controlling units:
  - An Application Controller
  - A BS Controller
- Design of signalling architecture allowing:
  - The transfer of cross-layer information within network nodes and over different RATs
  - The transfer of feedbacks and commands among different entities
    - From clients to controllers
    - Among controllers

The architecture at a glance

» Application Controller:

- adapt in real-time the source coding parameters and the protection rates
- owned by a Service Provider

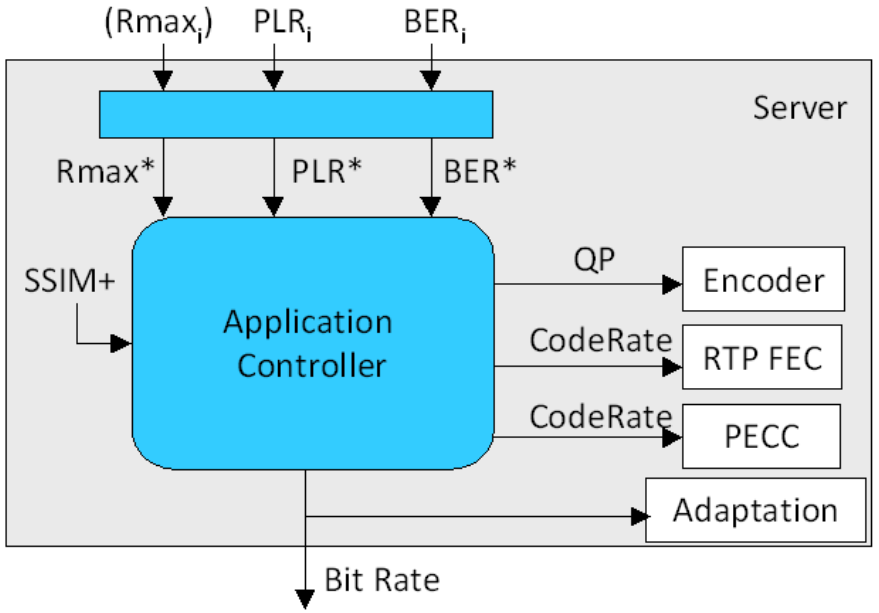


» Base Station Controller:

- allocate the shared radio resources among the users and the different kind of traffic

Application Controller

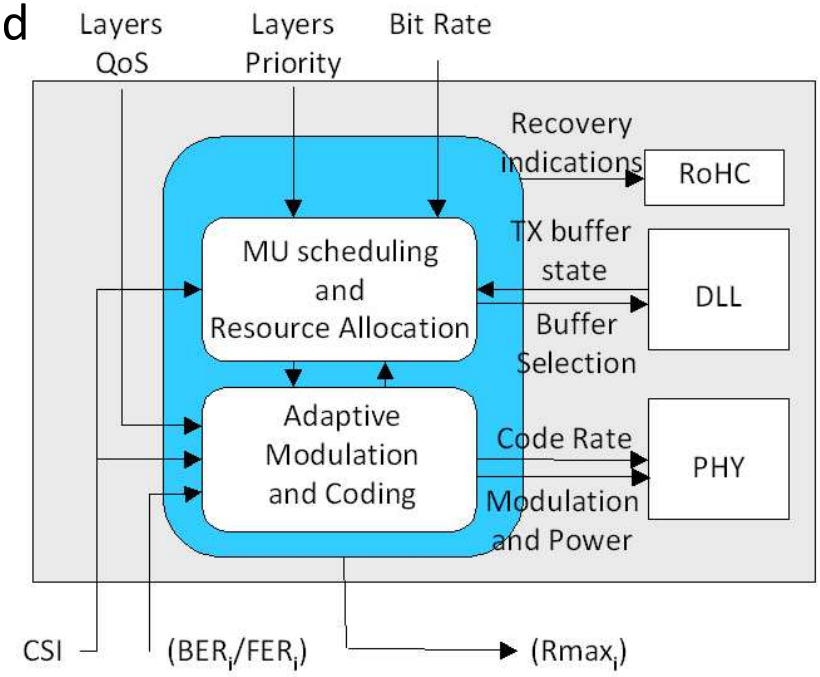
- Goal: control the compression and protection levels of video/audio streams based on the feedback information
- Inputs:
  - » maximum bit rate R_{max}
  - » Packet Loss and Bit Error Rate
- Outputs:
  - » QP to video encoder
  - » code rate to RTP FEC
  - » bit rate, frame rate
  - » layers priority (in IP headers)
- Optimization timescale: every second



- Point-to_multipoint adaptation based on clustering of feedbacks from clients
  - » Definition of a target user for a non scalable video stream (H.264/AVC)
  - » Definition of C target users for a scalable video stream (H.264/SVC)
  - » Several cost function definitions

Base Station Controller

- Goal: schedule downlink transmissions and assign common resources to users
- Inputs:
  - » channel conditions
  - » multimedia stream characteristics
  - » QoS requirements specified by the
  - » Service Controller
- Optimization time-scale: ms to follow variability of radio channels
- MIMO OFDMA radio architecture with maximization problem subject to:
  - » total transmission power
  - » target data rate for the video stream
  - » amount of data in TX buffers coupled to the priorities signalled by Application Controller



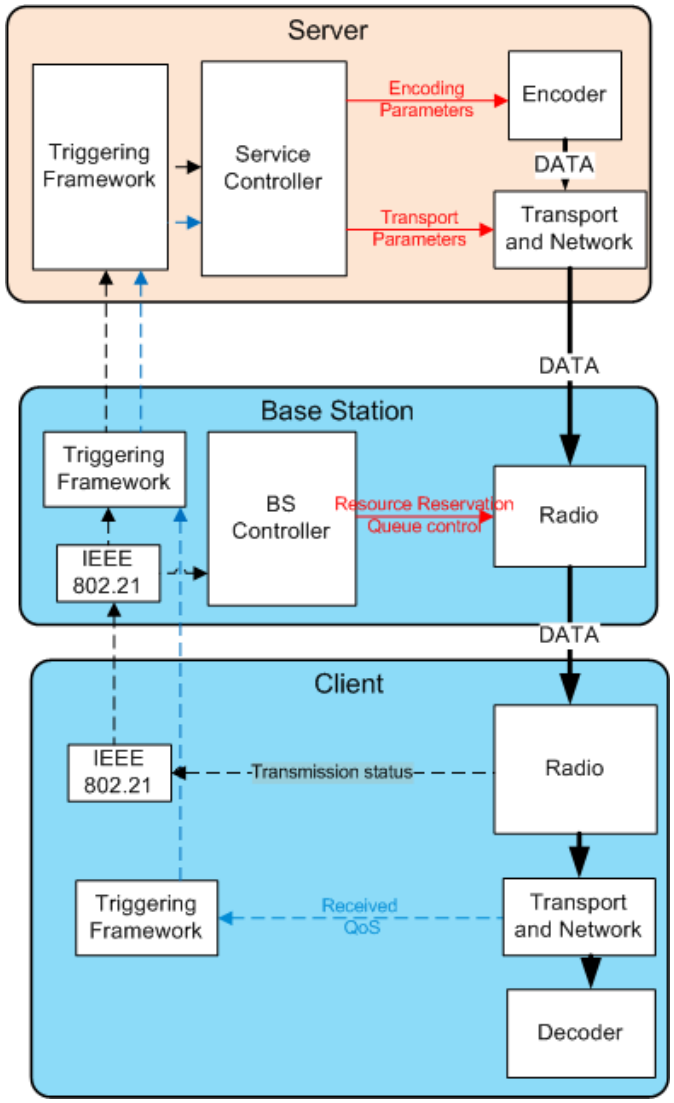
- Adaptive modulation and coding schemes applied to satisfy BER/FER requirements for the different video priorities

Cross/layer cross/node signalling

- Goal: transfer feedbacks and control information between layers and nodes
- Main features / elements:
  - » Cross-layer and end-to-end signalling
  - » IEEE 802.21 standard -based signalling
    - between Clients and Base Station to collect link and network information
    - IEEE 802.21 establishes the basis for heterogeneous handovers
    - Out of scope of IEEE 802.21:
      - Upper layer events (L3 and above)
      - End-to-end signalling for traffic control
  - » Triggering Engine (TRG)
    - between Clients and Server
    - for E2E corss-layer signaling

Triggering Framework

- Present in all nodes
- Trigger Format:
  - ID (Trigger identifier): e.g., Transport Layer Trigger
  - Type (Specific to the trigger identifier): e.g., Loss Rate
  - Value
- Allow exchanging information between trigger sources and triggering consumers
  - List of possible triggers (IDs and Types)
  - Registration by trigger sources
  - Subscription by trigger consumers
    - for specific values (use of filters)
- Trigger aggregation
- Transport layer (L4) transmission
  - end-to-end transmission of Application and Base Station Controller triggers
  - end-to-end transmission of Radio node feedbacks (interface with 802.21)

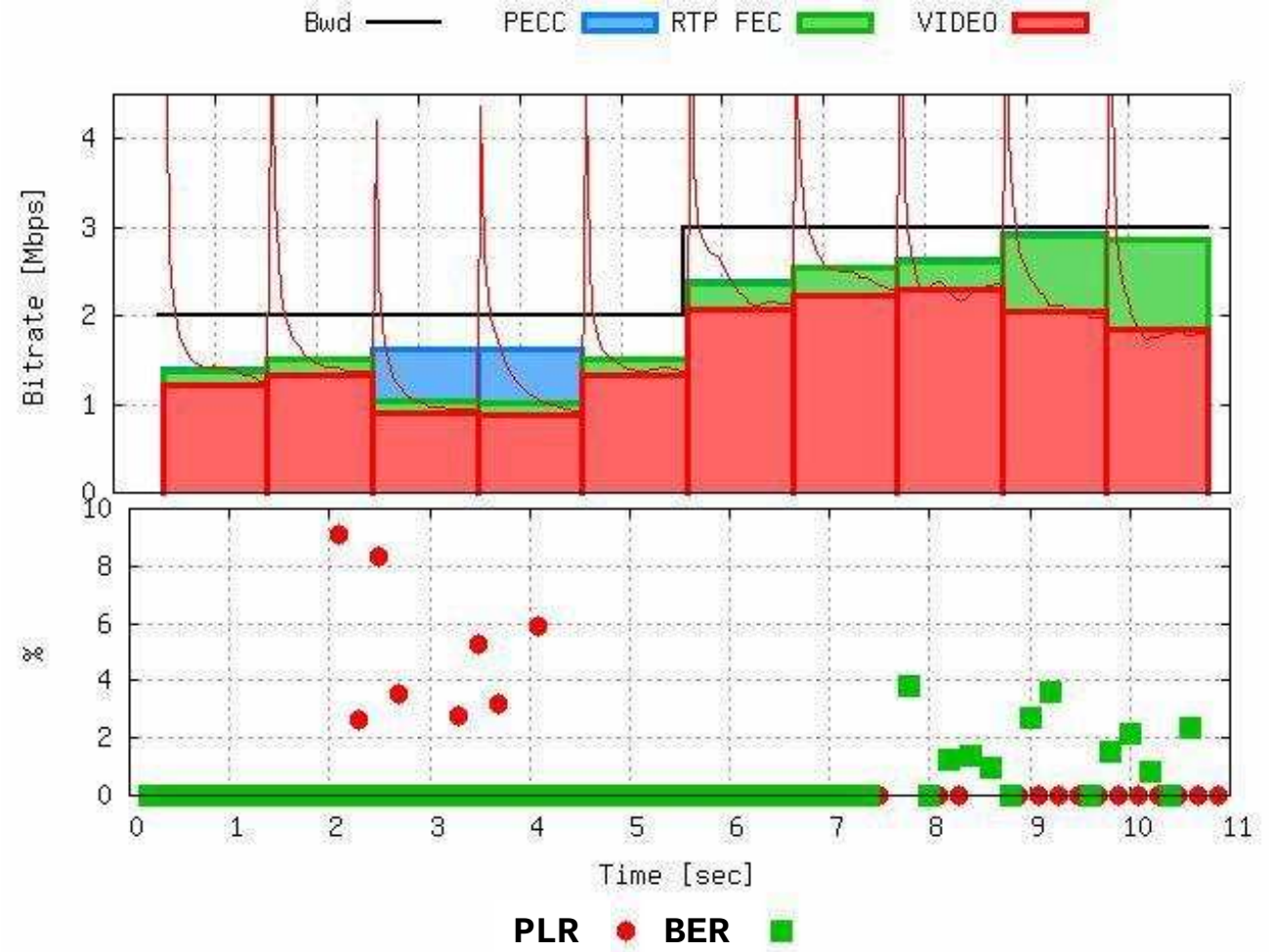


OPTIMIX system-level aggregation

- Introduction of network-level aggregation for overhead reduction:
  - Introduction of Feedbacks Aggregation Servers (FASs)
  - Exploitation of IPv6 anycasting
- Anycast IPv6 :
  - Packet delivery in IPv6 standard besides unicast and multicast
  - Definition of an anycast group
  - A packet addressed to an anycast address is delivered to the ”closest” node according to a predefined metric (hop count, link state, server load, etc.)
- In OPTIMIX signalling architecture:
  - Anycast group composed by the FASs and the Server itself
  - Feedback messages are addressed to the Feedback Anycast Address
  - Delivery to an aggregation server or directly to Application Controller
  - Aggregation servers collect feedbacks into common IP packets
    - Single packet with multiple values
    - No values aggregation to avoid decisions in FASs
  - IP packets are sent to the Application Controller by unicast

Example of OPTIMIX results

Application Controller behaviour in point to point transmissions

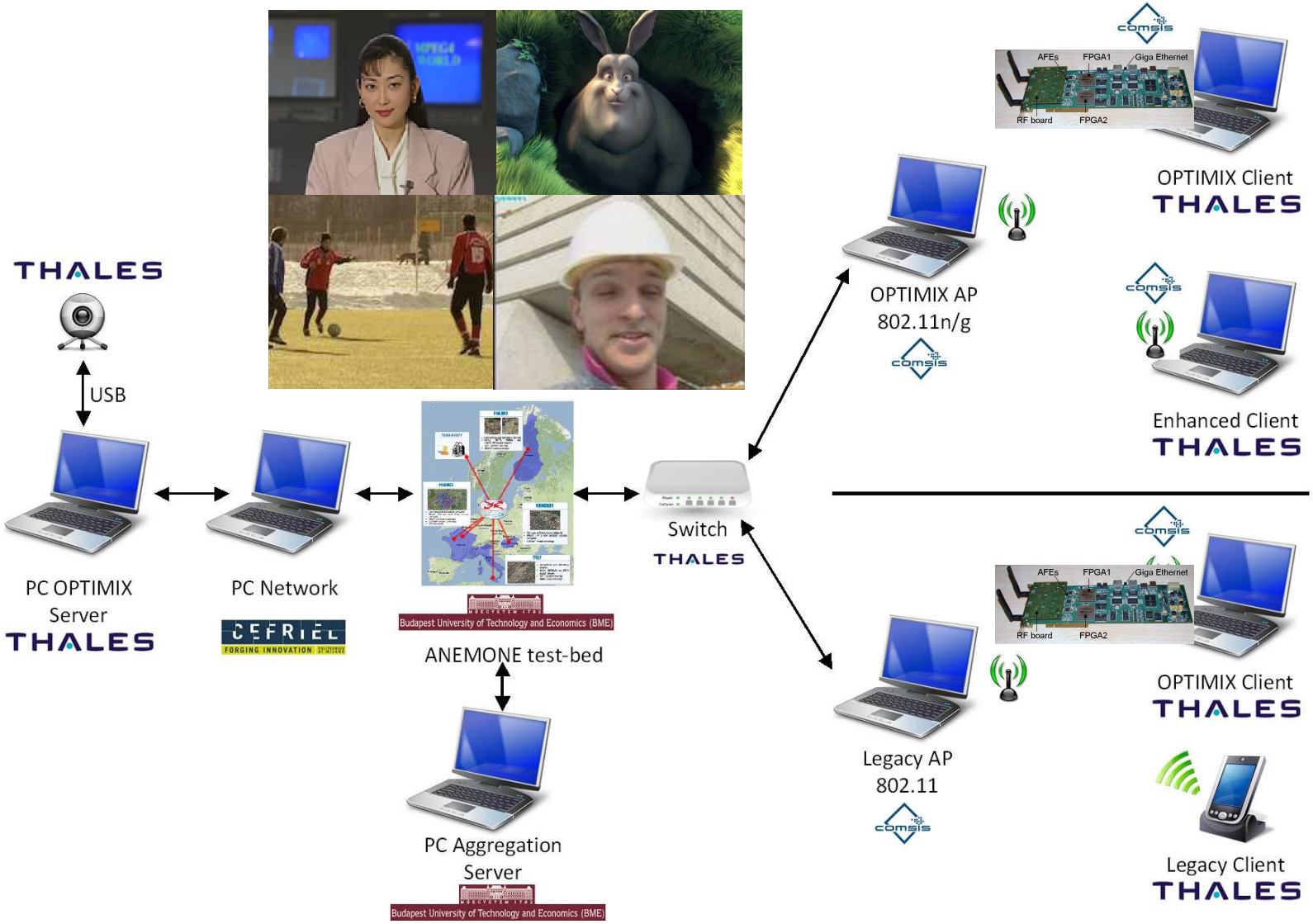


OPTIMIX simulator

- Realization of a system simulator :
  - » Using OMNeT++ framework
  - » Based of collaborative work of most partners
  - » Implementing all layers (from application to physical)
  - » Transmitting real bits of information
  - » Modelling control information
  - » Including WP2 and WP3 solutions

- http://www.ict-optimix.eu/index.php/OPTIMIXsim

OPTIMIX test-bed



Conclusions

- Research WPs ended in Aug. 2010
  - » 6 patents
  - » More than 100 papers
- Current activity is final evaluation via:
  - » Simulations using the OPTIMIX tool
  - » Experiments on the real-time test-bed
- Both objective metrics as well as subjective video quality evaluation are addressed

- OPTIMIX results will be presented at the OPTIMIX workshop at VTC Spring 2011 in Budapest:
  - » http://www.ieeevtc.org/vtc2011spring/Optimix.pdf
  - » Deadline for submissions: 1st December

Thank you!