A European high speed Access Platform and Residential Gateway

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Outline

A European high speed Access Platform and Residential Gateway
- Asymmetric PON
- Distributed Caching
- Residential Gateway
- Demonstrator
A European high speed Access Platform and Residential Gateway

Asymmetric PON
## FttX: How to combine the benefits of P2P & PON solutions?

- (without inheriting the disadvantages)

<table>
<thead>
<tr>
<th></th>
<th>PON</th>
<th>P2P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside plant</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Downstream Optics</td>
<td>+ (single OLT Tx)</td>
<td>- (2N TRx)</td>
</tr>
<tr>
<td>Power &amp; Footprint</td>
<td></td>
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<tr>
<td>Multicasting</td>
<td>- (BMT @ ONU)</td>
<td>- (2N TRx)</td>
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<tr>
<td>Upstream Optics</td>
<td>- (BMR @ OLT)</td>
<td>+ (P2P)</td>
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<tr>
<td>Upstream Electronics</td>
<td></td>
<td></td>
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<tr>
<td>MAC Complexity &amp; Overhead</td>
<td>- (TDMA)</td>
<td>+ (synchronous)</td>
</tr>
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</table>
Asymmetric PON (TDM/SDM version)

- Features
  - Downstream PON
    - broadcast and select **standard GbE**
  - Upstream P2P **GbE** (no shared media, no BMR, no BMT)
  - Standard IEEE 802.3 compliant
    - 1000Base SX or LX
    - **cheap** ONU and OLT transceivers
Electro-optics: Downlink Transceivers

- 48 downlinks @ 100 Mb/s
- Optics
- Dissipation
- Footprint (width)

**P2P**
- 48 SFF FE
- 48 W
- 67 cm

**AsPON**
- 5 SFP GbE + 4 PORx
- 7 W
- 15 cm

**Saving**
- 86%
- 77%

12 ports
LC2WFQ Scheduler

- Huge Differentiation in Services and QoS Requirements
- Decentralized Control
- Design Considerations:
  - Fairness
  - Low Latency (bounded)
  - Time Complexity
  - Design Complexity
  - Distributed Design
- Round Robin versus Weighted Fair Queuing

```java
1. while(true)
2.   s1=lowerbound;
3.   s2=lowerbound;
4.   for (i=0 ; i<flows; i=i+1)
5.     if (notEmpty(queue[1])) then
6.       size=getSize(head(queue[1]));
7.       s1 = MAX(s1, (credit[i]-size/weight[i]));
8.     if s1 > s2 then
9.       s2=s1;
10.      packet_size=size;
11.     index=i;
12.     end if
13.   end if
14. end for
15. send(dequeue(queue[index]));
16. active=active-1;
17. credit[index]=credit[index]-packet_size/weight[index];
18. for (i=0; i<flows; i=i+1)
19.   if (notEmpty(queue[1])) then
20.     credit[i]=credit[i]+packet_size;
21.   else
22.     credit[i]=0;
23.   end if
24. end for
25. readjustcredit(queue[1..i],lowerbound);
26. end while
```
LC2WFQ Scheduler (simulation)
(Port 1,12,23: 64B. Port 2,13,24: 512B. Rest: 64-1500B. All ports: 41.6Mb/s)

Maximum Latency

- LC2WFQ
- WFQ
- DRR

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LC2WFQ Scheduler (simulation)
(Port 10 and 21 Misbehave (200Mb/s instead of 41.6 Mb/s)
Prototype Block Diagram

Features:
- Six individual or cascaded sections
- 1 Gbit/s per eight users
- Aggregation up to 6 Gbit/s
- Use of normal Ethernet MAC protocols
- No additional data bus for payload between FPGAs
- Ethernet data plane
- Distributed management system
- Multiple transmitters for downstream PONs
- More flexible power budget
Prototype of the Platform

- Power Supply
- QDR Memory
- Virtex 4 LX100
- Configuration
- Clock

**10 port MAC**
- 14 layer PCB
- 4 power rails
- 48 users in 6 clusters of 8 users
- < 5W per user (worse case)
- Producible PCB (feature & insulation)

**GbE SFP**

**12 RX array**
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Distributed caching
Content Distribution in Access Networks

- Future access loads will clog aggregation networks
- Content will require smart distribution
- Or users will share peer-to-peer anyhow…
Caching: how

- Size matters, more than anything else.

![Graph showing Byte Hit Ratio vs Total Storage size (in bytes)]
Caching: where

- No Cache
- Central Cache
- Remote Cache
Caching: distributed

Peer2Peer File Sharing

Distributed Peer2Peer Caching
Distributed Peer2Peer Caching

- **Design:**
  - N-copy File rotation
  - No protocol
  - No overhead
  - Content agnostic (HTTP, FTP, …)

- **Implementation:**
  - HTTP
  - Tracker
  - Client proxy
  - Linux/Windows process

- **Simulation**
Simulation analysis (efficiency, 100 Clients)

![Graph showing Byte Hit ratio vs Total Storage size in Byte]

- Maximum
- Central Cache
- Distributed Cache
- Cache Client Ensemble
- Peer to Peer Ensemble
Simulation analysis (responsiveness)

Hit Ratio

- Maximum
- Central Cache
- Distributed Cache
- Cache Client Ensemble
- Peer to Peer Ensemble

Total Storage size [Byte]
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Residential Gateway
RESIDENTIAL GATEWAY FUNCTIONALITIES

- Per flow and per interface QoS provisioning
- Local CAC mechanism
- IMS enabled RGW
- Hybrid NAT traversal mechanism (ALG + STUN)
- RGW authentication based on 802.1X
- Flexible management and configuration (web browser, TR069 protocol, SIP, SNMP, etc.)
- Service gateway capabilities demonstrated by means of an e-care management bundle that runs in the RGW itself
RESIDENTIAL GATEWAY ARCHITECTURE

- Data level functionalities:
  - Classification/VLAN tagging
  - Policy/Shaping
  - Dispatcher/Queue System
  - Scheduling

- Control level functionalities
  - SIP signaling processes
  - Call admission control module
  - TISPAN/NGN compatibility
RESIDENTIAL GATEWAY MANAGEMENT

- RGW management based on DSL-forum TR-069 remote management protocol. It allows to:
  - Encode the wire SOAP/XML/HTTP
  - Provide the RPC like getParameterValues
  - Define the parameters in the MIB
  - Apply the changes to the routing/forwarding functionality of the RG

- OSGi bundle management dual approach
  - Based on OSGi specific procedures
  - Based on TR-069 procedures
RESIDENTIAL SERVICE GATEWAY

- As the number of services increases, a number of advantages arise if a single device acts as a service gateway common to different services
  - Possibility of interaction between different services, allowing the construction of new services
  - Centralization of services configuration and management processes
  - A single approach can be used regarding access, control and personalization of services by the user
  - The cost of the service gateway hardware can be shared between the different service providers
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Demonstrator

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Demonstrator

Alcatel-Lucent

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Thank you