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COMPARATIVE STUDY OF OPTICAL ACCESS TECHNOLOGIES

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Abstract

The main purpose of this study is to show a general overview of different access technologies and make general comparisons of technologies from several points of view. Unfortunately, convertible, general and cross vendor data series are not available so typical model situations are used to establish the comparisons. During this study the technologies were in the focus. The statements are product independent as much as possible.

Keywords: FTTL, PON, AON, HFC.

1. The Main Features of Competing Access Technologies

An extended set of wireline and wireless access technologies are available recently. They can be classified by the transmission media, the supported services and the node structure. The main wireline transmission technologies are: twisted pair based copper cables with traditional and enhanced working mode, coaxial cables, fibre cables. The main wireless technologies are: broadcasting, fixed radio and cellular systems. As nature of information the voice, data and video service provision can be identified. The general elements of services are: content provision, content and service packaging, distribution and presentation. The presentation may contain different levels of interactivity. The node structures are more or less determined by economic optimum considering the geographic distribution of customers, selected transmission technologies and the services.

This study dealing with the FTTL architectures as the comparison of AON, PON and HFC technologies will be in the focus below. Anyhow other technologies like wireless access can be used as references in price or flexibility comparisons. According to this terminology the active optical networks (AON) contain in the optical connection part some kind of electronic or optical equipment for amplifying, branching, multiplexing. The passive optical networks contain passive splitters only in this part of the networks. The integrated hybrid fibre coax (IHFC) networks contain a single fibre and a single coax cable part for several services. The optical part of IHFC systems might be either passive or active.

2. Analysis Concerning Customer Distribution

The customer distribution generally can be specified by figures like user/km^2 or Erlang/km^2 and the ratio of business/residential customers. In Hungary in 1997 it is a crucial issue whether an access network is initiated by the public telephony local concession holder migrating towards the free competition areas like CATV and data services or starting from free competition areas and later extending with telephony.

*R*ural *a*rea (RA), some hundred customers, dominant residential users and some small business, single houses, POTS and CATV services are needed, basic infrastructure is existing:

*S*mall *t*own (ST), about 20.000 inhabitants, about 100 business customers concentrated in the very city and in the outside industrial ring of the town, 80% of customers in single houses, basic infrastructure is existing, distribution and presentation of voice, data and video information is gradually increasing at reasonable prices.

*M*etropolitan *a*rea (MA), more than 100 thousand inhabitants, more than 1000 business customers distributed mostly in the city and the industrial area, 80% of customers are in block houses, basic infrastructure is existing, distribution and presentation of voice, data and video information is gradually increasing at reasonable prices. The access network investor is the temporary exclusive concession holder for local telephony and should have to get dominant market share of the competitive businesses.

*C*ompetitive *m*etropolitan *a*rea (CMA), more than 100 thousand inhabitants, more than 1000 business customers distributed mostly in the city and the industrial area, 80% of customers are in block houses, basic infrastructure is existing, distribution and presentation of voice, data and video information is gradually increasing at reasonable prices. The access network investor has no concession for local telephony but has a dominant market share of the competitive businesses and should have to be the second telephone operator if the local monopoly is terminated.

3. Analysis Concerning the Utilisation of Existing Networks

*G*reen*f*ield situation (GF): the existing infrastructure is practically negligible or obsolete or has complete reconstruction.

*P*artially *a*vailable *h*oles in the existing duct system (PAH): the majority of the fibre part and 30 – 50% of the copper part can utilise the spare holes.

Well-established good quality *co*ax network exists for CATV distribution (CO): the majority of dwelling units are connected to the system.

Table 1.

	AON	PON	IHFC
RA Advantage	No practical distance limit between host and active node, one active node can serve the whole settlement	The system is expandable almost gradually by small steps. The copper drop lines are short.	Service capabilities fit to the service demand for long run.
Disadvantage	Limited reliability due to the several remote powering, one remote switch is rather economical and manageable	OLT-splitter distance is limited at 20 km	Distance limit in the coax part.
ST Advantage	Business users in the city can be served efficiently by the big active node.	The exact geographic distribution of bandwidth and service demand is not critical in the planning phase, the system bandwidth can reach any of ONU units.	Service capabilities fit to the service demand.
Disadvantage	Equipment is not flexible. Low density areas have long copper part.		Distance limit in the coax part
xMA Advantage	Business users in the city can be served efficiently by the big active node.	The exact geographic distribution of bandwidth and service demand is not critical in the planning phase, the system bandwidth can reach any of ONU units.	Efficient serving of high density CATV demand.
Disadvantage			Limitations in broadband business communication services.
CMA Advantage	Easy to realise remote overlay network	The exact geographic distribution of bandwidth and service demand is not critical in the planning phase, the system bandwidth can reach any of ONU units.	CATV and VOD services are good cost carriers in the initial phase.
Disadvantage			Low service flexibility, limitations in broadband business communication services.

Table 2.

	AON	PON	IHFC
GF Advantage	A cost effective and future proof network plan can be constructed.	A future proof flexible network structure can be built even at limited demand forecast. The FTTC – FTTB migration of ONU positioning can be calculated.	
Disadvantage	Accurate demand forecast is necessary for the optimal network planning.		The best promising services for the top customers are risky for long run.
PAH Advantage	The most of the available holes are utilisable.	Due to the relative freedom of splitter and ONU allocations the available duct holes fully utilisable without disturbing the PON network structure optimum.	
Disadvantage	The most promising SDH ring topology of the AON networks usually do not fit to the existing branching structure.		
CO Advantage		The PON version of IHFC fit well to this model.	The investment intensive part of the existing network is fully usable.
Disadvantage	The trxaditional CATV network structure does not fit to the AON structure so the existing assets are only partially utilisable		
TP Advantage	The existing and tested POTS distribution networks are fully utilisable. The cutover procedure can be managed without disturbing the customers.	The existing and tested POTS distribution networks are partially utilisable. The cutover procedure can be managed without disturbing the customers.	
Disadvantage			The existing assets are not usable.

Table 3.

	AON	PON	IHFC
POCA Advantage		Possible cost efficient co-deployment of NB and BB solutions.	IHFC is developed for such service portfolio.
Disadvantage	Relatively high initial investments are not paid back with cheap mass services.	Relatively high initial investments are not paid back with cheap mass services.	High risk that competitors bypass the business with attractive services on demand.
IIM Advantage		Flexible bandwidth allocation following the actual demands.	The management and especially the billing systems are developed for demand oriented pricing and billing.
Disadvantage:			Limited flexibility of the system concept especially in high bandwidth transparent digital transmission.
BBHB Advantage	Fibre to the business/building solutions are the most cost effective.	Smooth transitions from Fibre to the Curb solutions towards the Fibre to the Building systems are possible.	
Disadvantage	The profit on pure bandwidth provision will eroding. Climbing on the value chain is in the hand of content provider, content and service packaging and brokering side.		Limited high bandwidth transparent digital transmission.
FUSE Advantage	This technology support ATM as transport and access tool.	This technology supports highest level of the ATM as transport and access tool.	
Disadvantage			This technology does not support the ATM as the main transport and access tool for full service networks.

Well-established good quality twisted pair distribution and drop network exists for POTS services (TP): the majority of dwelling units are connected to the system.

4. Service Evolution Issues

*POT*S and *CA*TV (fixed program distribution) are dominant cost carriers for long run (POCA).

*I*nternet, *I*SDN, *m*ultimedia, information brokering, information on demand, home working will have fast penetration within the planned period and the small and medium size enterprises with one considerable layer of residential customers are the dominant cost carriers (IIM).

*B*ig *b*usiness users are the dominant customers, the network operator provides *h*igh *b*andwidth only for them (BBHB).

*F*ull *s*ervice network is desirable within the planned network evolution period (FUSE).

5. List of Abbreviations

AON *A*ctive *O*ptical *N*etwork
ATM *A*synchronous *T*ransfer *M*ode
CATV *Ca*ble *Te*le*v*ision
FTTB *F*ibre *t*o *t*he *B*uilding
FTTC *F*ibre *t*o *t*he *C*urb
FTTL *F*ibre *t*o *t*he *L*oop
HFC *H*ybrid *F*ibre *C*oax
IHFC *I*ntegrated *H*ybrid *F*ibre *C*oax
OLT *O*ptical *L*ine *T*erminal
ONU *O*ptical *N*etwork *U*nit
PON *P*assive *O*ptical *N*etwork
POTS *P*lain *O*ld *T*elephony *S*ervice
SDH *S*ynchronous *T*ransmission *S*ystem
VOD *V*ideo *o*n *D*emand

6. Conclusion

As the multiple analysis can clearly show there is no single and ultimate technology for all applications in the optical access networks. The selection of best technologies and products needs careful market analysis and forecast or to push the network operators towards the most flexible solution to follow the rapid changes of market needs. The highest flexibility in the optical

access networks can be reached to push the optical/electrical converter units as near as possible to the customers. The passive optical systems have the highest flexibility to move ONU-s gradually towards customers in the evolving access network.

The optical part of IHFC might be active or passive so the PON version has higher flexibility.

The NB solutions are most enhanced on PON and AON systems. The CATV services have the most enhanced support by IHFC technology. Nowadays the co-deployment seems to be the most reasonable common solution consequently by passive optical part.

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