
Coexistence with Current Systems

- 10GE-PON System Configuration –

ver.1.2

Supporters

Name	Company
Hiroshi Hamano	Fujitsu
Tetsuya Yokomoto	Fujitsu Access
Motoyuki Takizawa	Fujitsu Access
Keiji Tanaka	KDDI R&D Labs.
Yoshifumi Hotta	Mitsubishi
Junichi Nakagawa	Mitsubishi
Akihiro Otaka	NTT-AS
Shuji Kimura	NTT-AS
Naoto Saeki	NEC
Ken Shiraishi	NEC
Seigo Takahashi	NEC
Kiyoshi Uematsu	OKI
Hiroshi Murata	Sumitomo
Shinji Tsuji	Sumitomo

Presentations on Coexistence at IEEE Meetings

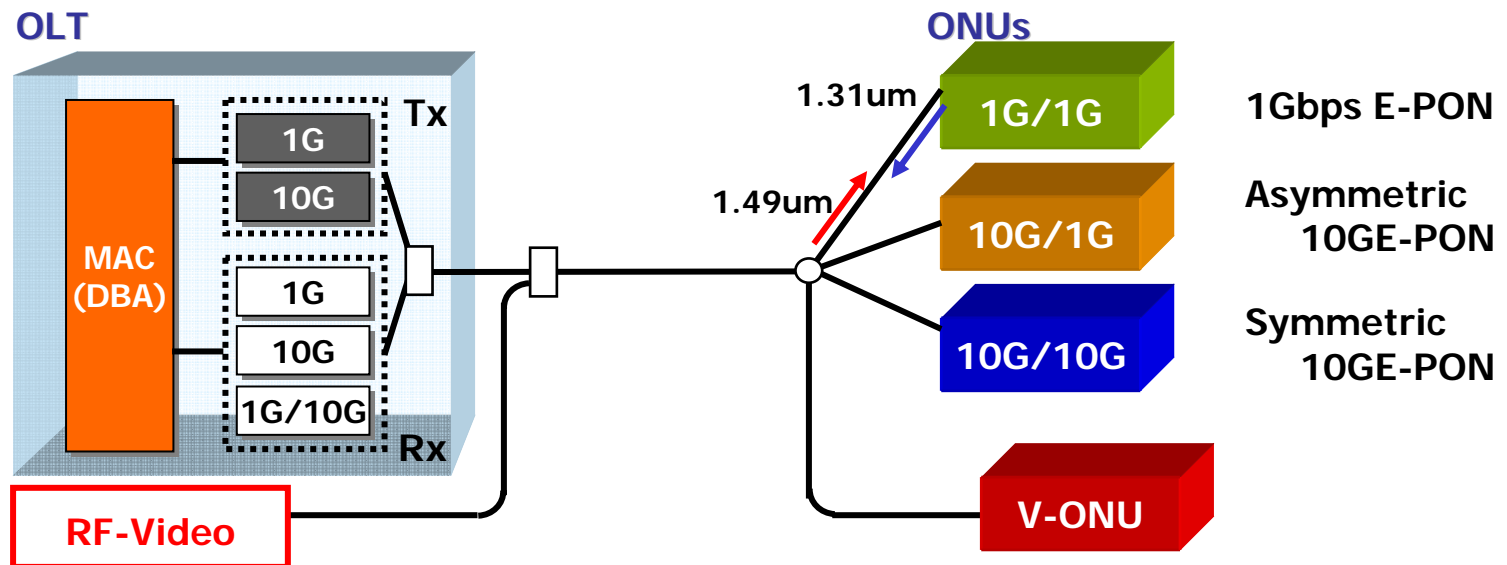
Meeting	File #	Company	Architecture	PHY	MAC
2006.5 (Austin)	murata_1_0506	Sumitomo	✓	✓	
	mukojima_1_0506	OKI	✓		
	otaka_1_0506	NTT	✓		
	tanaka_1_0506	KDDI R&D	✓		
2006.7 (San Diego)	effenberger_1_0706	Huawei		✓	
	merel_1_0706	Luxtera	✓	✓	
	hirth_1_0706	Teknovus	✓		
	mukojima_2_0706	OKI	✓		✓
	takizawa_1_0706	Fujitsu	✓	✓	
2006.9 (Knoxville)	3av_0609_ben-amram_1	PMC	✓	✓	✓
	3av_0609_hajduczenia_1	Siemens	✓		
	3av_0609_tsuji_1	Sumitomo	✓	✓	
	3av_0609_tanaka_1	KDDI R&D	✓	✓	
2006.11 (Dallas)	No report				
2007.1 (Monterey)	3av_0701_tatsuta_1	NTT	✓	✓	
	3av_0701_kramer_1	Teknovus	✓	✓	✓
	3av_0701_hajduczenia	Siemens	✓	✓	
	3av_701_uematsu_1	OKI	✓	✓	
	3av_0701_effenberger_2	Huawei	✓	✓	

Objective

Propose 10GEPON configuration (TDM- or WDM-based configuration) achieving coexistence with current systems of 1Gbps-PON and RF-video, on the following conditions:

- No change of currently deployed 1G-ONU
- No change of outside optical fiber plant with a channel insertion loss of 29 dB

Coexistence Configuration



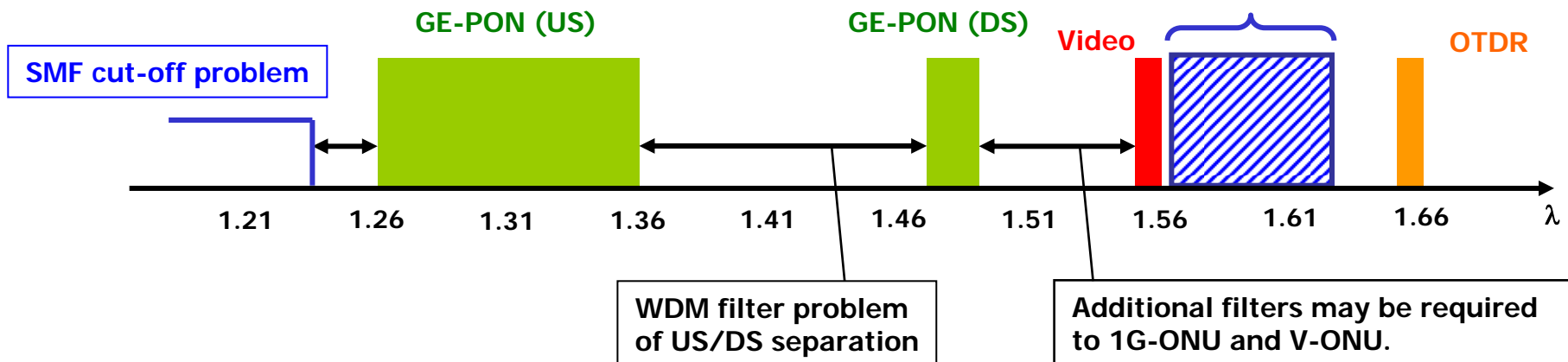
Wavelength Allocation for 10GE-PON

(Question)

Which wavelength band can be used for 10GE-PON system?

Wavelength Plan (Ref. :3av_0609_tsuji_1.pdf)

Candidate for 10GE-PON : L-band



➔ (Conclusion)

Available band for 10GE-PON is only L-band to achieve coexistence with current systems.

Upstream : Asymmetric 10GE-PON Overlay to GE-PON

(Question)

Which overlay scheme is preferable for coexistence with GE-PON and asym. 10GE-PON, TDM- or WDM-based, to the upstream direction?



	TDM (1.31um)	WDM
ONU (Tx)	<ul style="list-style-type: none"> • Same as 1Gbps EPON 	<ul style="list-style-type: none"> • Only λ is different from 1Gbps EPON.
	<ul style="list-style-type: none"> • Same as 1Gbps-EPON • DBA for 1Gbps-EPON is applicable. 	<ul style="list-style-type: none"> • Additional Rx is required. • A WDM-filter is required, which results in loss budget decrease by 1dB.
OLT (Rx)		

➔ (Conclusion) **TDM-based overlay is preferable.**

Upstream : Asym./Sym. 10GE-PON Overlay to GE-PON

(Question)

Which overlay scheme is preferable for coexistence with GE-PON, asym., and sym. 10GEPON, TDM- or WDM-based, to the upstream direction?



	TDM (1.31um)	WDM
ONU (Tx)	<ul style="list-style-type: none"> • 10GbE(LX)-based DML is applicable. (Detailed λ band should be decided.) 	<ul style="list-style-type: none"> • Cooled type-EML may be required. • Detailed λ band should be decided.
OLT (Rx)	<ul style="list-style-type: none"> • Dual-rate burst Rx is required. • Dual-rate DBA operation is required. • Low aggregate bandwidth 	<ul style="list-style-type: none"> • A WDM-filter is required, which results in loss budget decrease by 1dB.

➔ (Conclusion) **TDM-based overlay is preferable** in terms of the cost. However, WDM-based overlay should be also considered associated with power budget ad hoc.

Upstream : Candidate of the Upstream Wavelength

(Question) Which wavelength is the best to the upstream direction, when we have to adopt WDM-based overlay scheme?

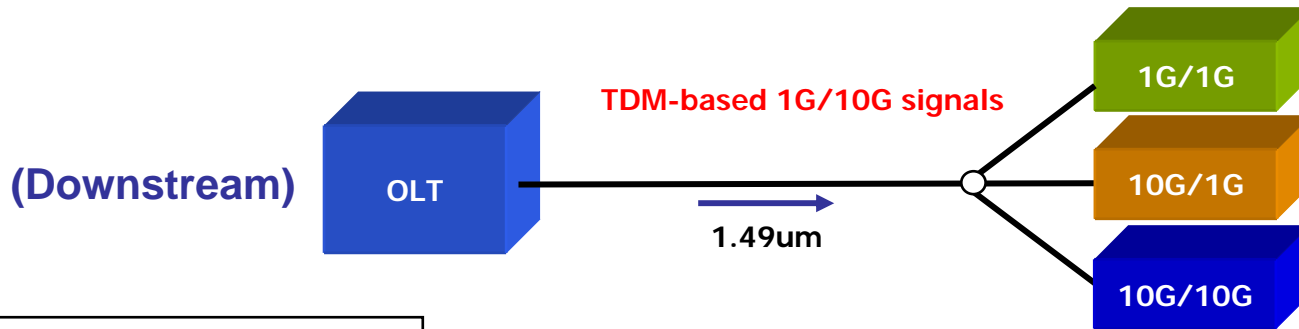
Item		1.57 μ m	1.59 μ m	1.31 μ m (Ref.)
Practicality/cost of transceiver				Very Good
Feasibility/cost of optical filter	@OLT			
	@ONU			
	@V-ONU			
Reflection tolerance				
Coexistence with OTDR				
Compatibility with downstream λ				
Total practicality				

We need to decide upstream wavelength by considering all the associated factors totally including the achievable power budget.

Downstream : TDM-based Overlay Scheme

(Question)

Is TDM-based overlay practical for coexistence with GE-PON, asym., and sym. 10GEPON, to the downstream direction?



Non-WDM overlay method

Method	Practicality	Comment
1G/10G signal mixing (continuous)	Hard	Existing GE-PON is not able to support 10Gbps-speed.
1G/10G orthogonal pol. multiplexing	Hard	Polarization tracking is required at ONUs
IM(1G)+DPSK(10G) transmission	Hard	Balanced receiver is required at 10G-ONUs

Ref.: 3av_0609_hajduczenia_1.pdf



(Conclusion)

TDM-based overlay is impractical, and WDM-based overlay is considered to be the most promising to downstream direction.

Downstream : Candidate of the Downstream Wavelength

(Question) What is the best wavelength in L-band for 10GE-PON downstream?

Item		1.57um	1.59um	1.61um	C-band (Ref.)	1.49um (Ref.)
Practicality/cost of transceiver		No significant difference				
Practicality/cost of optical filter Most important issue	@OLT					
	@ONU					
	@V-ONU	We are studying the practicality of each blocking filter.				
Adoption of optical amplifier	SOA	Output power is limited to +10~12 dBm.				
	EDFA	A high output power of >14dBm is available.				No
Coexistence with						
GE-PON (+7dBm)		Marek's calculation will be referred.				N/A
RF-Video (+x dBm)						
OTDR					No problem	
ODN compatibility		Is the split ratio of splitters accurate?			No problem	
Total practicality						

Conclusion

- By reviewing the proposals in IEEE meetings and systematically narrowing the 10GE-PON system configuration achieving coexistence with current systems, we found that
 - US : **TDM-based overlay is preferable**, but WDM-based one should be also considered associated with power budget ad hoc.
 - DS : **WDM-based overly using L-band is only one solution.**

Next step

- (1) Summarize pros and cons of each λ candidates in page 8 and 10
 - Feasibility study of blocking filters at OLT and ONU
(A variety of optical filter configurations, such as a combination of two types of filters, should be also considered.)
 - Estimation of interference impairments with current systems
- (2) Propose the best λ for 10GE-PON systems

Appendix-1 : Tx/Rx cost comparison on L-band

(Question) How is the cost of optical transceivers on L-band wavelength?

Proposal from OKI

		Full WDM	10G/1G WDM	US TDM, DS WDM
Wavelength		1565nm - 1580nm, 1591nm		
		4 λ s US:10G/1G, 10G/10G DS:10G/1G, 10G/10G	2 λ s US: 10G/10G DS:10G/1G and10G/10G	1 λ DS:10G/1G and10G/10G
Power budget		Channel Insertion loss : 29dB + Penalty : 2dB		
DS	OLT-Tx	Type	EML(D-WDM)+SOA	
		Cost	1.1	
		Remark	Cooled type LD is required.	
	ONU-Rx	Type	PIN-PD / APD	
		Cost	1 / 7	
		Remark	PD type depends on results in power budget ad hoc.	
US	ONU-Tx	Type	EML(D-WDM)	
		Cost	4.5	
		Remark	Cooled type LD is required.	
	OLT-Rx	Type	SOA+ PIN-PD / APD	
		Cost	35/1	
		Remark	PD type depends on results in power budget ad hoc.	

(Conclusion) **DS: No significant difference** is expected between TDM and WDM overlay.
US: TDM overlay has an advantage since DML is applicable to ONUs.