北京郵電大學
BEIJING UNIVERSITY OF POSTS AND TELECOMMUNICATIONS

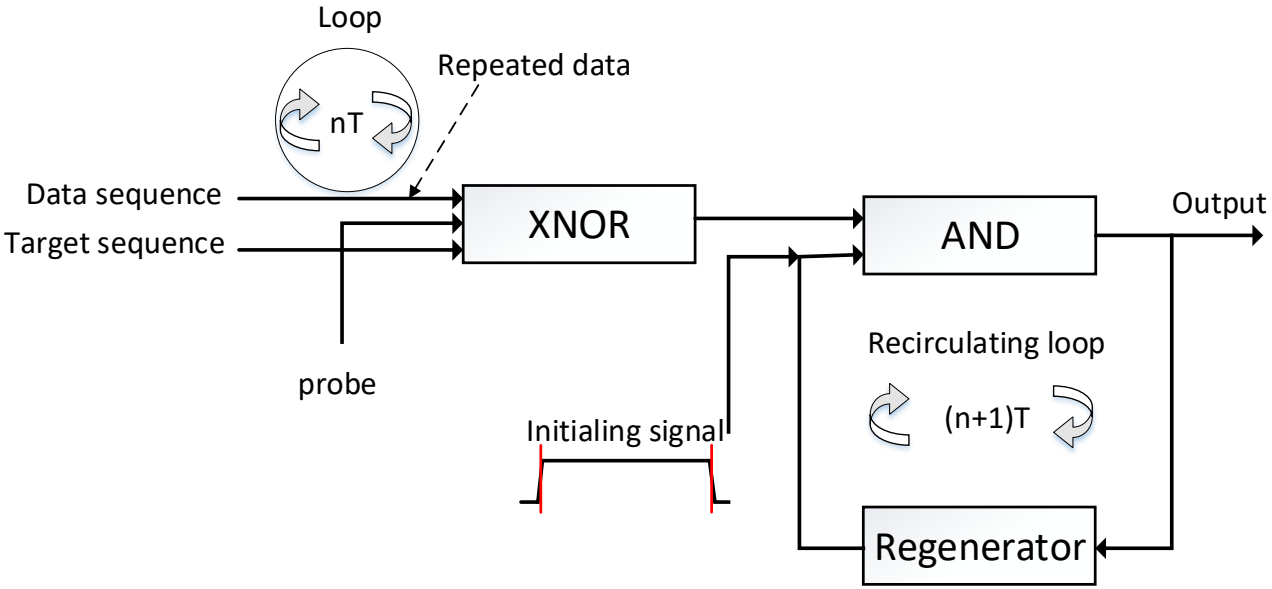
UCDAVIS
COMPUTER SCIENCE

New Architectures for Photonic Firewall

Speaker: Ying Tang

02/07/2020

WISDOM Architecture



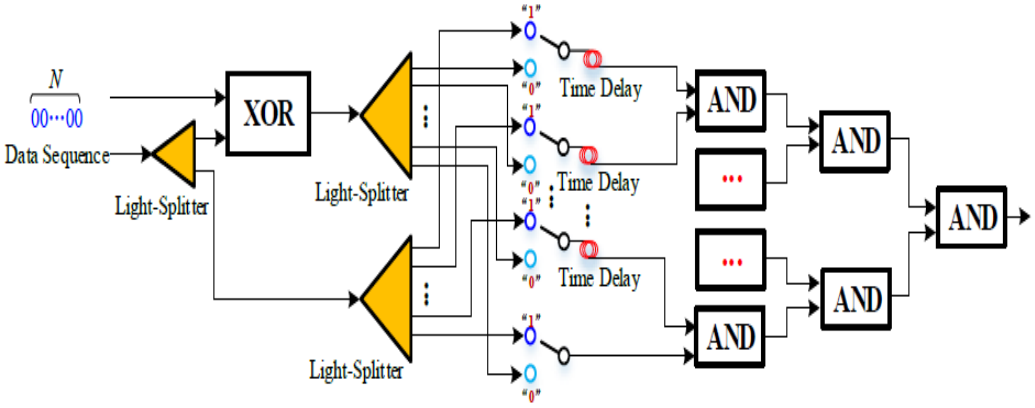
Advantages:

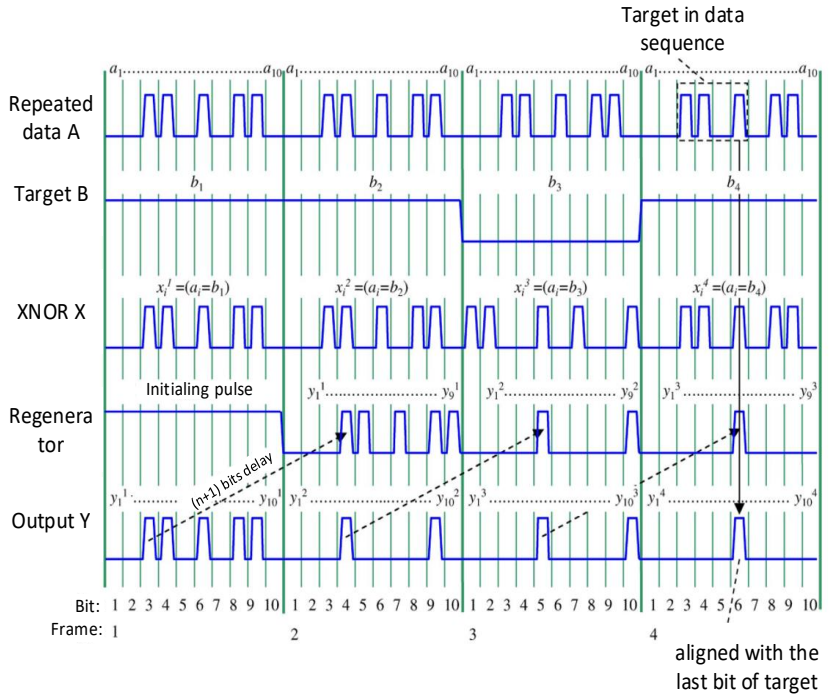
- WISDOM operated at 42.6 Gbps which was good for DWDM.
- Using SOA which is off the shelf.

Drawbacks:

- Operation beyond 100 Gbps is desirable now (1 Tbps).
- Device needs to be passive (conserve energy).
- Reduce the pattern matching time.

Parallel Recognition System



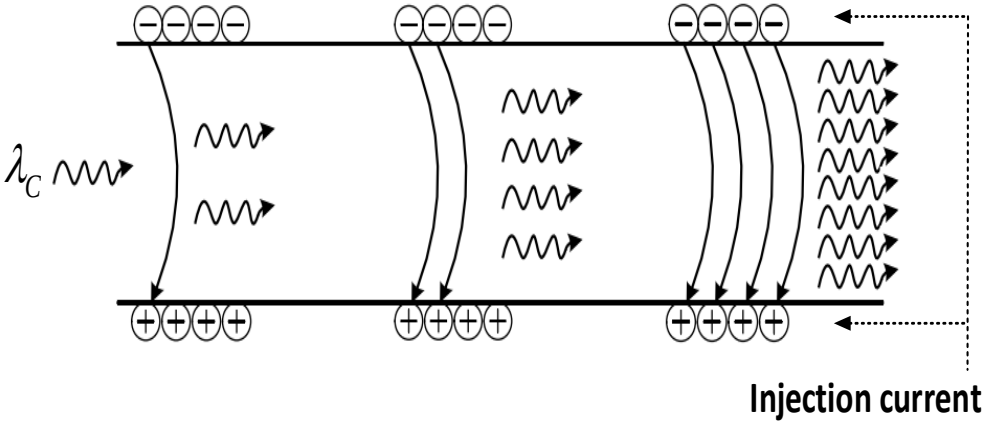


- This architecture reduce the pattern matching time.
- The limitation of data rate is still remaining.

X. Li et al., "Parallel All-Optical Binary Recognition System for Short Sequence Detection Applied in Photonic Firewall," in *Asia Communications and Photonics Conference (ACP)*, Chengdu China, November 2019.

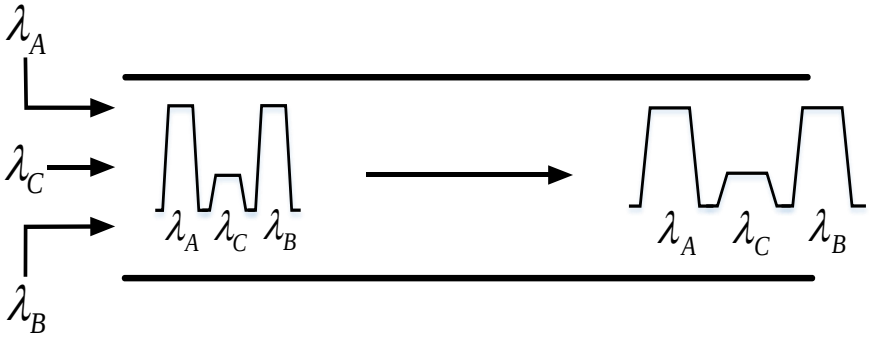
Why HNLF?

SOA



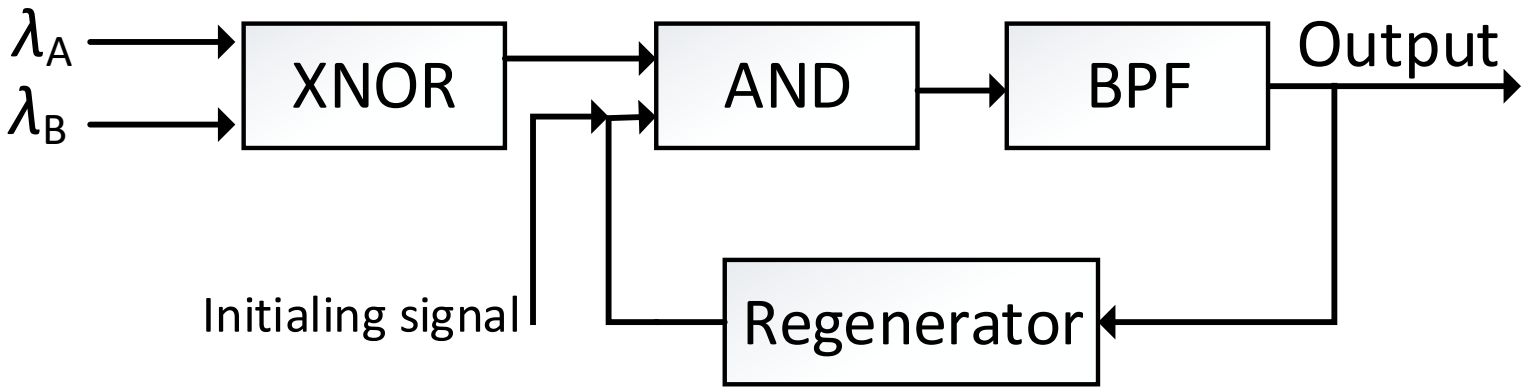
- The carrier recovery time is limited by the stimulated emission process.
- The processing data rate is also limited.

HNLF



- XPM & SPM are natural process in nonlinear fiber.
- Related to P, γ, L, λ separation.
- Process is much faster than that in SOA.
- Passive device.

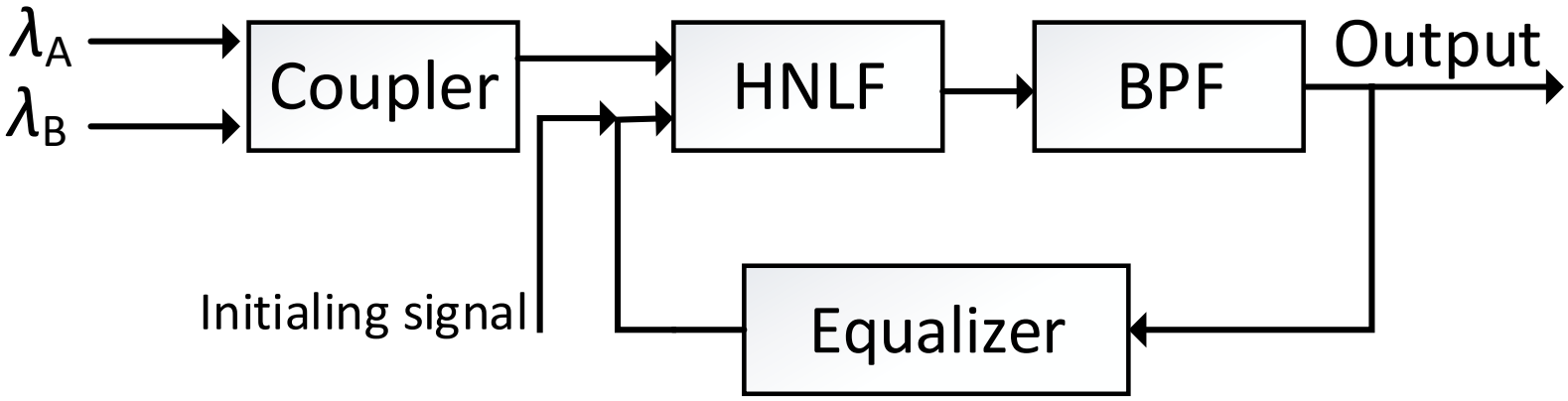
Proposed Design for HNLF

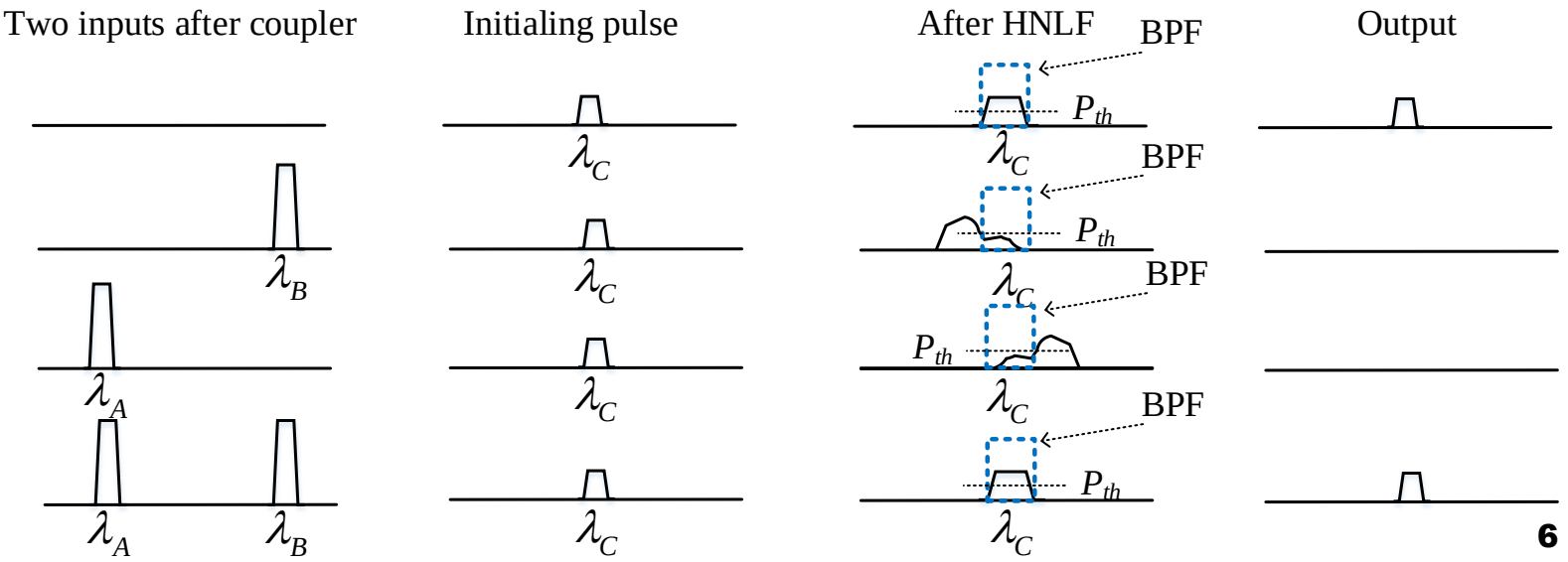


True Table

λ_A	λ_B	XNOR	AND		Output	
0	0	1	0	1	0	1
0	1	0	0	1	0	0
1	0	0	0	1	0	0
1	1	1	0	1	0	1

Proposed Design for HNLF





Extinction Ratio

Why extinction ratio (ER) is important?

- Distinguish different states.

How to increase the value?

- Increase the launched power *P*.
- Change the material (γ, α, β).
- Change the wavelengths λ_A, λ_B, λ_C.
- Change the fiber length.

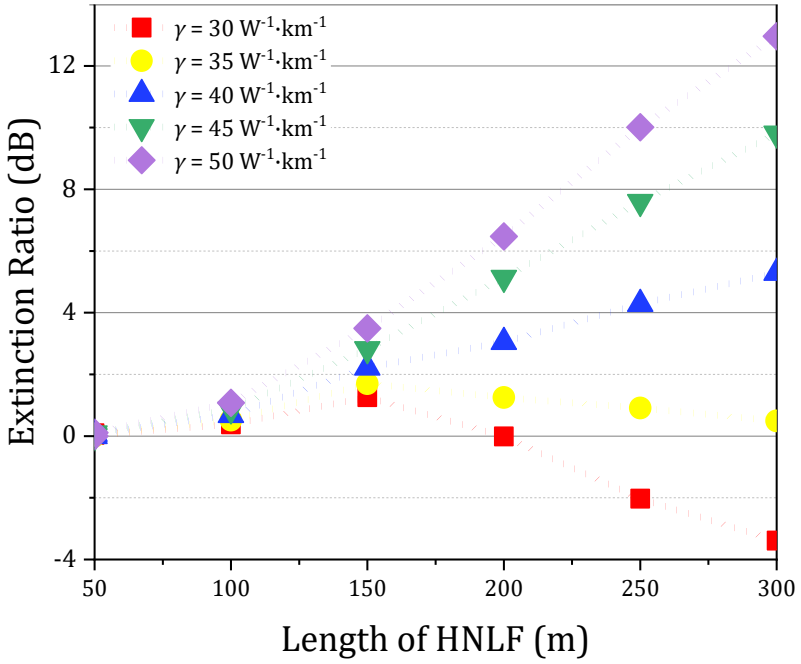
λ_A	λ_B	λ_C	P_C (dBm)
0	0	1	-9.71
0	1	1	-19.93
1	0	1	-19.72
1	1	1	-2.66

ER = -9.71 – (-19.72) = 10.01 dB

Extinction Ratio

Parameter setting:

- $P_A = P_B = 400$ mW, $P_C = 1$ mW.
- $\lambda_A = 192.9$ THz, $\lambda_B = 194.7$ THz, $\lambda_C = 193.8$ THz.
- The bandwidth of BPF is 50 GHz.



Parameters of each nonlinear fiber at 1550nm.

	γ	α	L_{eff_max}	γL_{eff_max}	L_{eff_1m}	γL_{eff_1m}	Coupling loss	Dispersion
HNLF	20	0.5	8686	173	1	20.0	0.1	0
Silica holey fiber (HF)	70	190	22.9	1.6	0.978	68.5	-	0
Bismuth-oxide fiber	1100	800	5.4	6.0	0.913	1096.0	2.9	-260
Bismuth-oxide HF	1100	3400	1.3	1.4	0.693	762.8	5.8	40
Tellurite HF	675	400	10.9	7.3	0.955	644.8	-	0
Lead-silicate HF	1860	3000	1.4	2.7	0.722	1343.1	-	210
As_2Se_3 chalcogenide fiber	1200	1000	4.3	5.2	0.893	1071.9	2.9	-504
	[1/W/km]	[dB/km]	[m]	[1/W]	[m]	[10^{-3} 1/W]	[dB/end]	[ps/nm/km]

Future Works

Phase 1:

- Design the feedback, complete the pattern matching system for 100 Gbps ($P_A = P_B = 400$ mW, $P_C = 1$ mW).
- Use different nonlinear fibers to reduce the launched power and fiber length.
- Go for higher data rate (beyond 100 Gbps), while still achieve the high extinction ratio.

Phase 2:

- Exploring the modulation format usage.

Thank you!

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