Optimizing CV quantum network and transduction protocols for optically connected microwave systems

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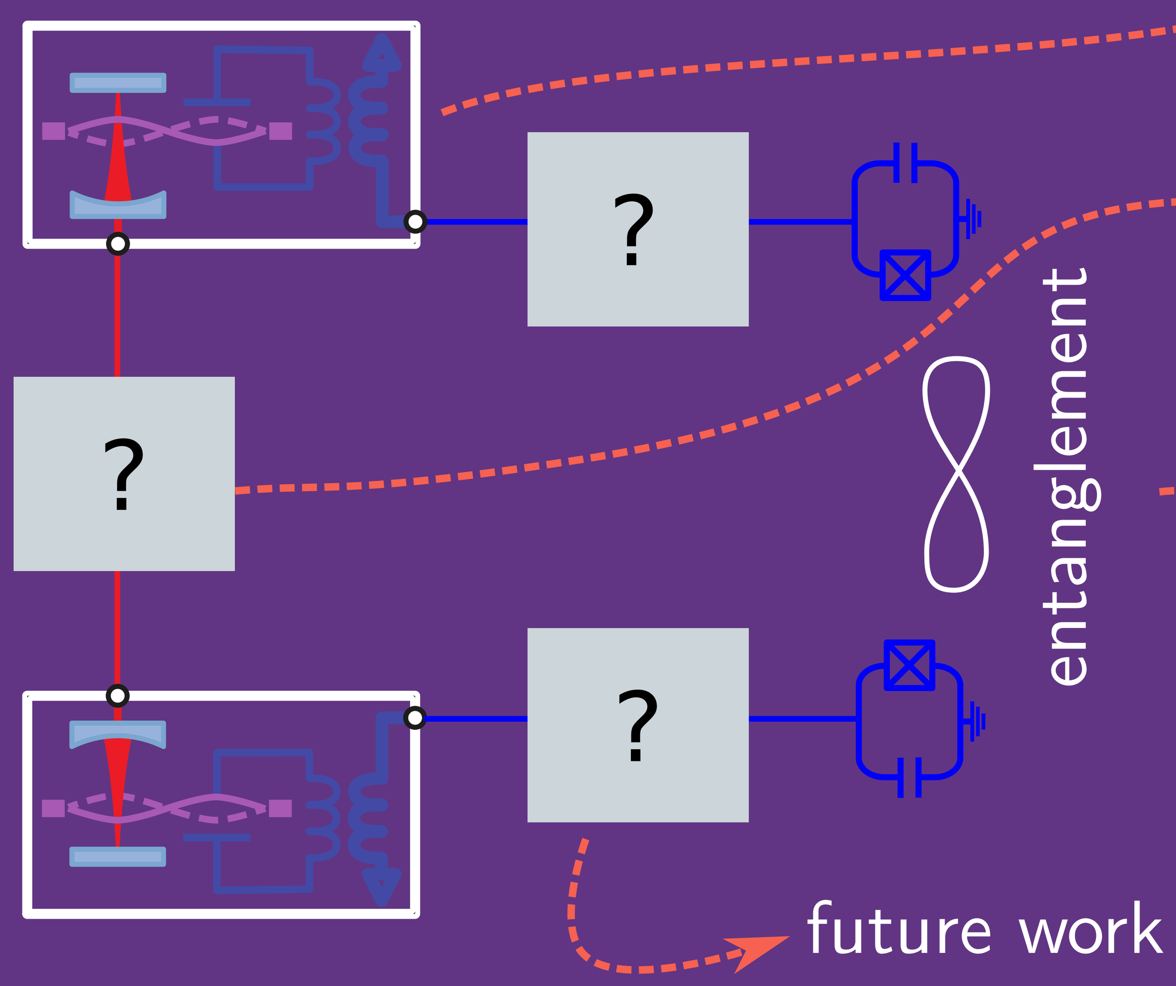
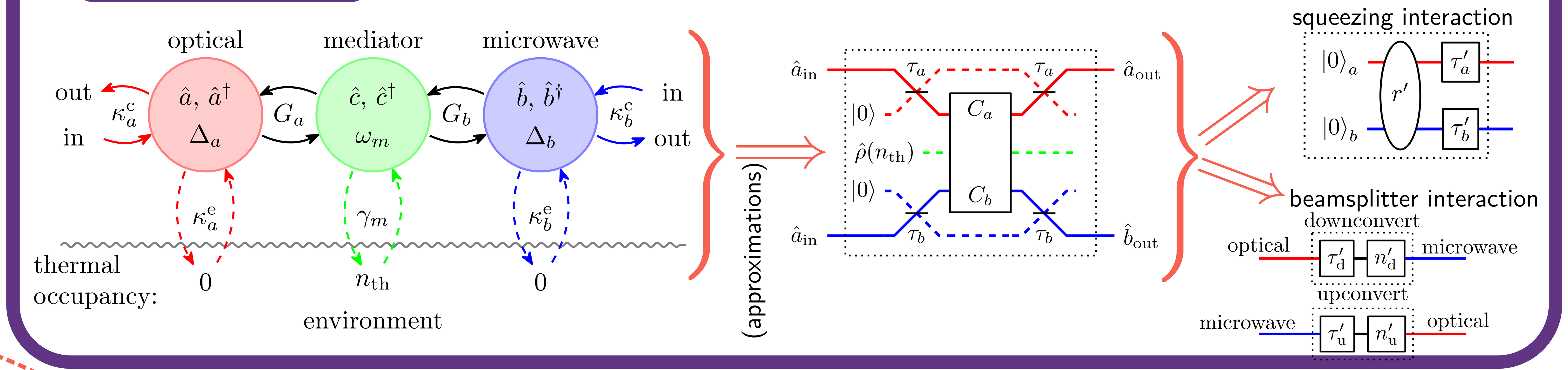
Quantum networks of optically-connected superconducting microwave qubits will implement communication protocols over physical network topologies. We show how the optimal network will depend on achievable transducer and network parameters along with the available ancillary states/measurements.

Scan me!
(links to poster & paper)

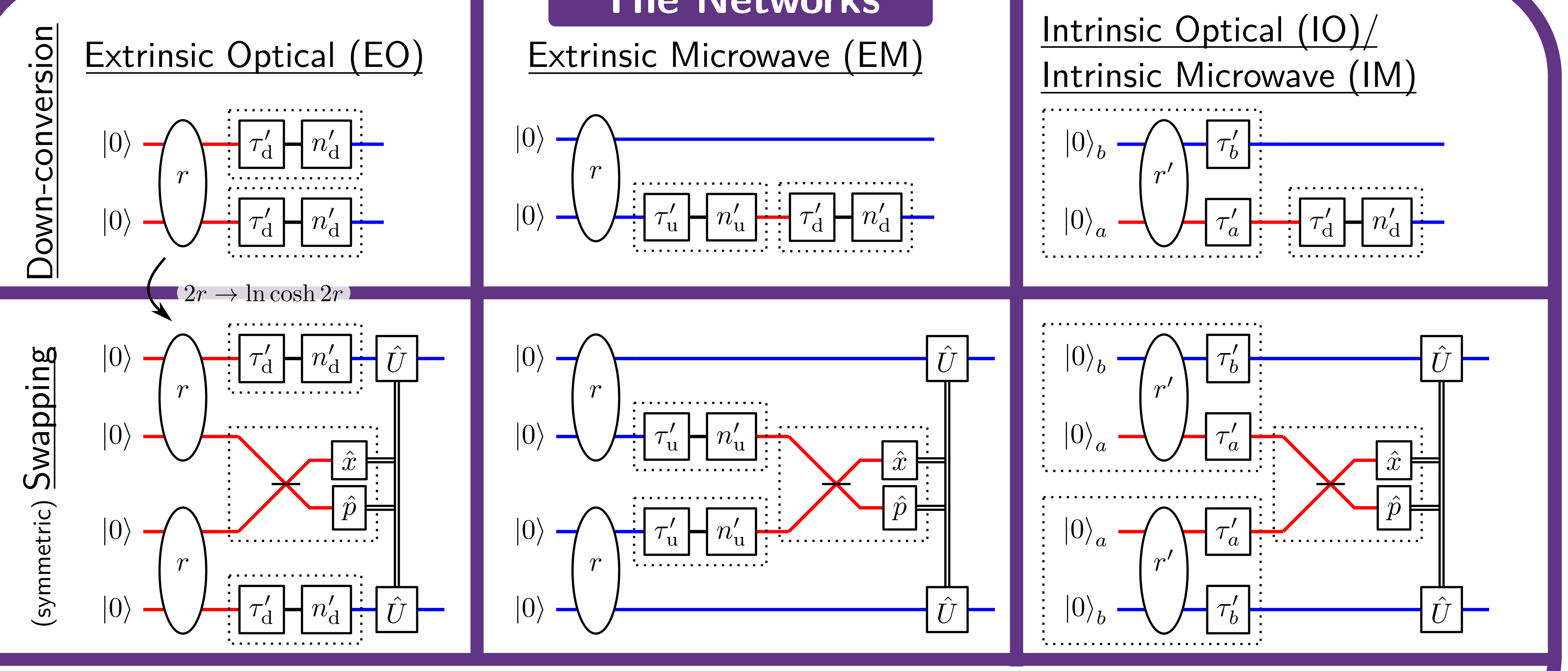


The Model

Doubly-parametric transducer (e.g. electro-opto-mechanical)



The Networks



Asymmetric swapping not-optimal*: Suppose two balanced-correlation two-mode Gaussian states $V_1 \neq V_2$

Asymmetric swap: $V_1 \oplus V_2$ Symmetric swap: $V_1 \oplus V_1$ or $V_2 \oplus V_2$ Then: $E_\mathcal{N}(V_{12}) \leq \max\{E_\mathcal{N}(V_{11}), E_\mathcal{N}(V_{22})\}$

Optimization & Comparison

Coupling efficiencies:

$$\tau_a = \frac{\kappa_a^c}{\kappa_a^c + \kappa_a^e}$$

$$\tau_b = \frac{\kappa_b^c}{\kappa_b^c + \kappa_b^e}$$

Cooperativities:

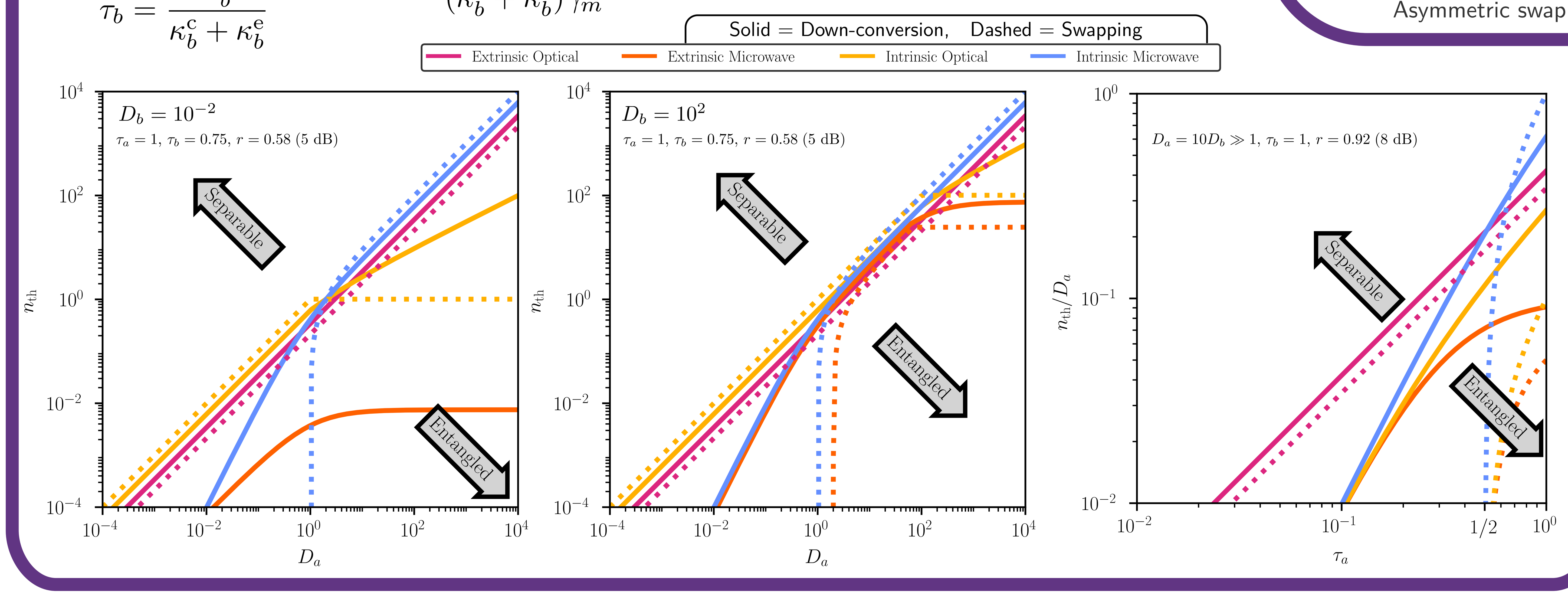
$$C_a = \frac{4G_a^2}{(\kappa_a^c + \kappa_a^e)\gamma_m}$$

$$C_b = \frac{4G_b^2}{(\kappa_b^c + \kappa_b^e)\gamma_m}$$

Optimize subject to constraints

$0 \leq C_{a,i} \leq D_a, \quad 0 \leq C_{b,i} \leq D_b$

+ stability conditions for squeezing interaction



External Optical loss

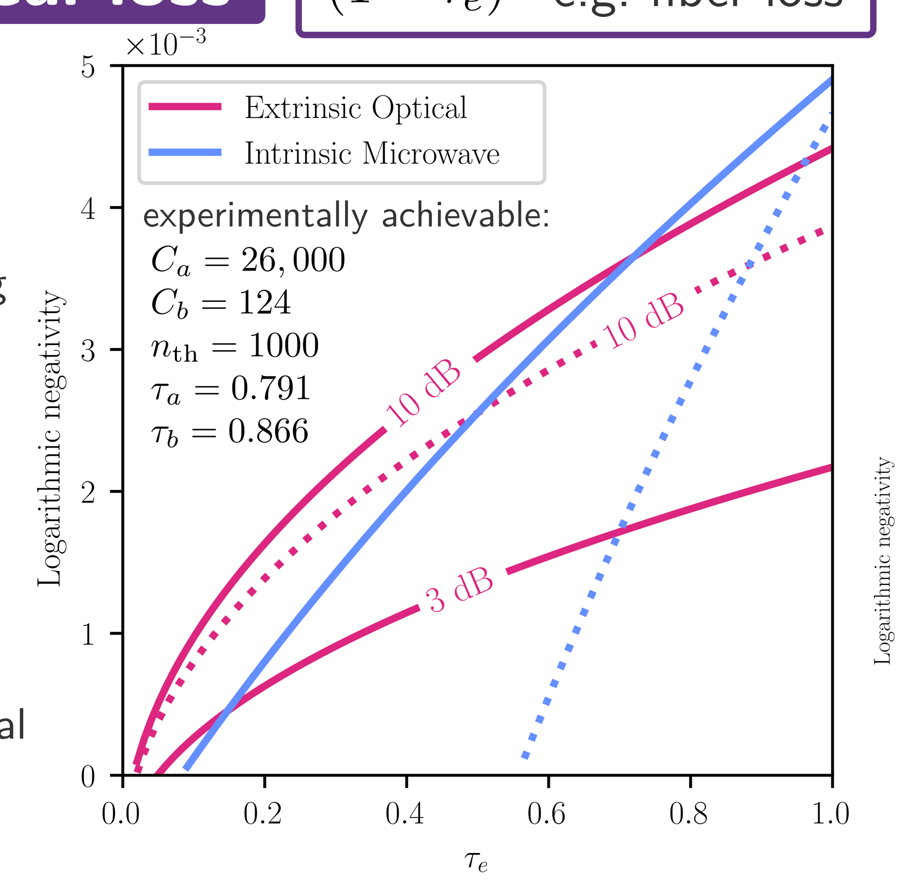
$(1 - \tau_e)$ e.g. fiber loss

Another optimization when allowing for arbitrary distribution on avalable optical modes.
=> *asymmetric swapping potentially optimal

For EO networks equal distribution of external optical loss is optimal:

$\tau_a \to \sqrt{\tau_e}\tau_a$

However, for symmetric swapping, completly unequal distribution of external optical loss is optimal.



*asymmetric swapping example: