

Power System Planning and Management

-- Long Term Transmission Expansion Planning via Real Options Evaluation

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I. Power System Planning

- Contains two major tasks:

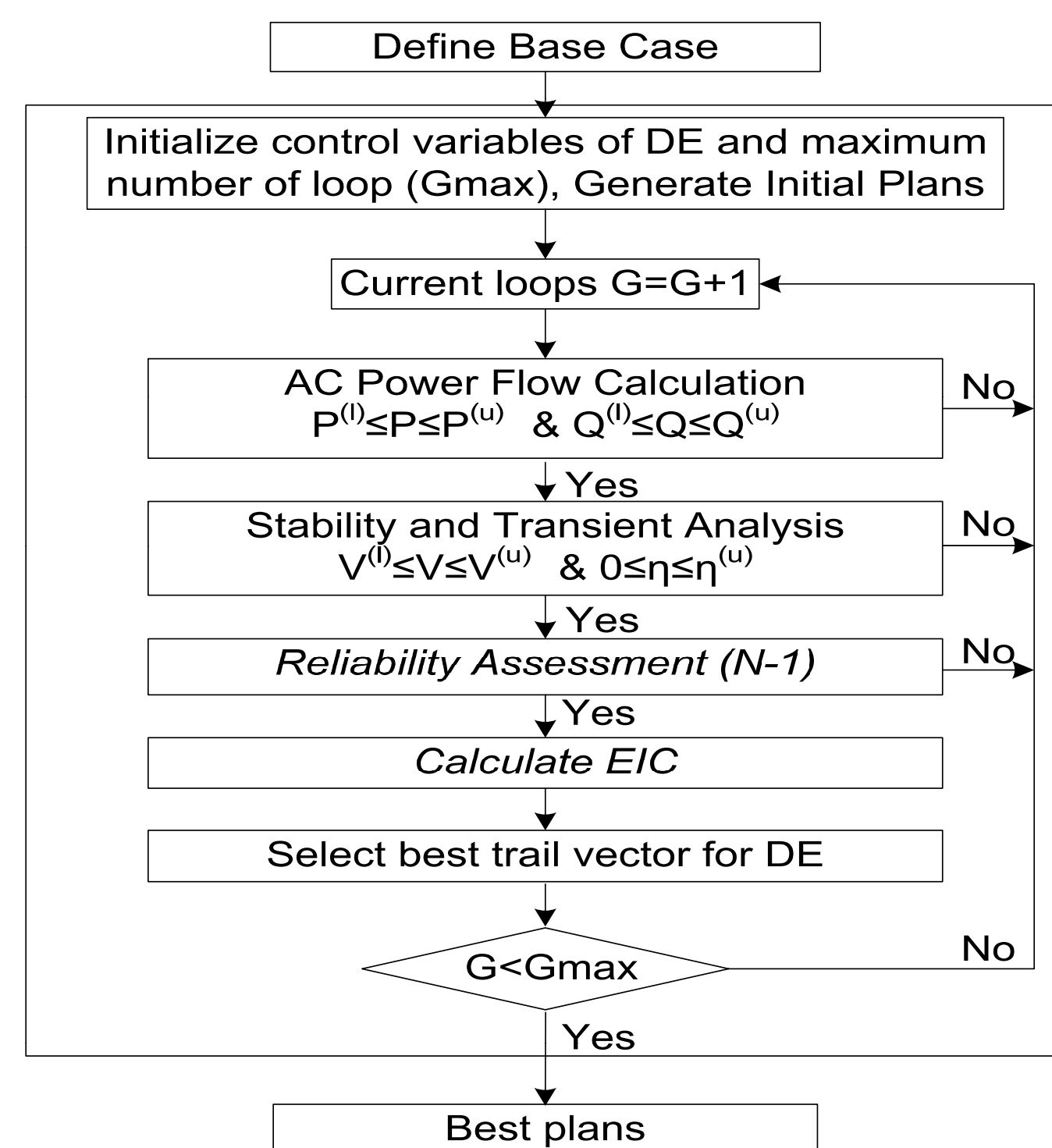
- Technical assessment

To ensure that customers at each load point could be reliably supplied with electrical energy, subject to system power flow balance, thermal limits, voltage limits and other various constraints.

- Financial evaluation

To justify the profitability of the project to the investing body.

I. Power System Planning – Technical Assessment

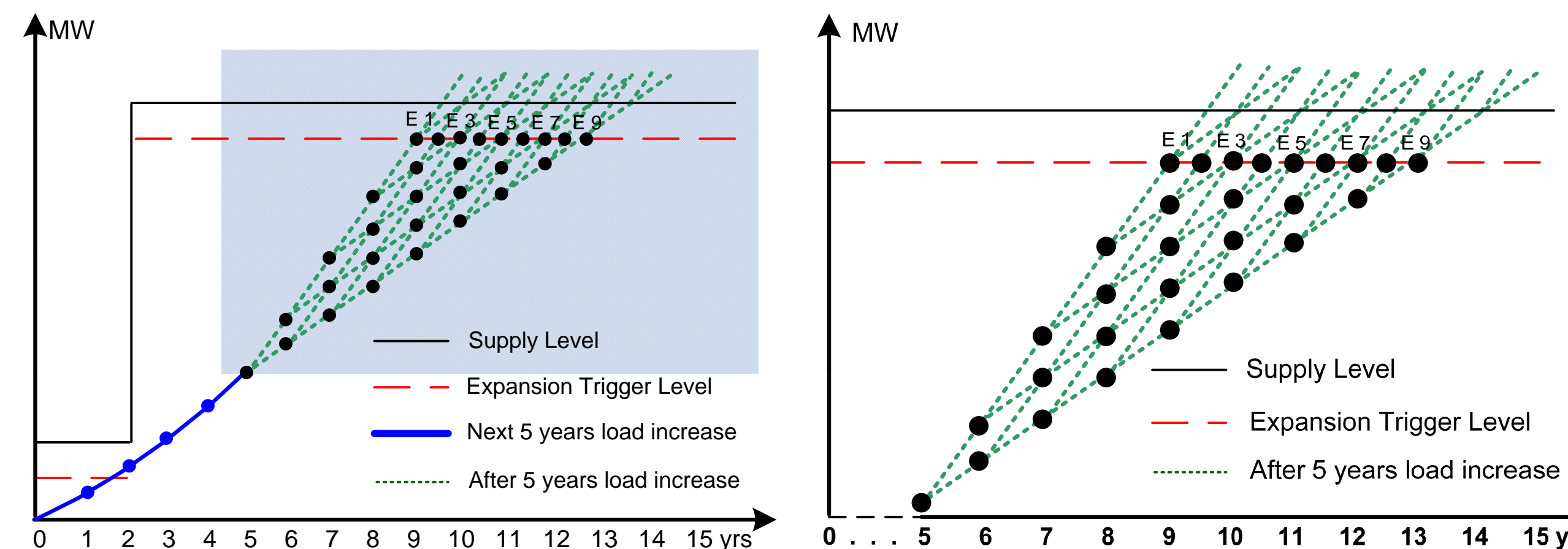


I. Power System Planning – Financial Evaluation

- Discount Cash Flow (DCF) based: Net Present Value (NPV) and Internal Rate of Return (IRR)
- Real Options (RO).

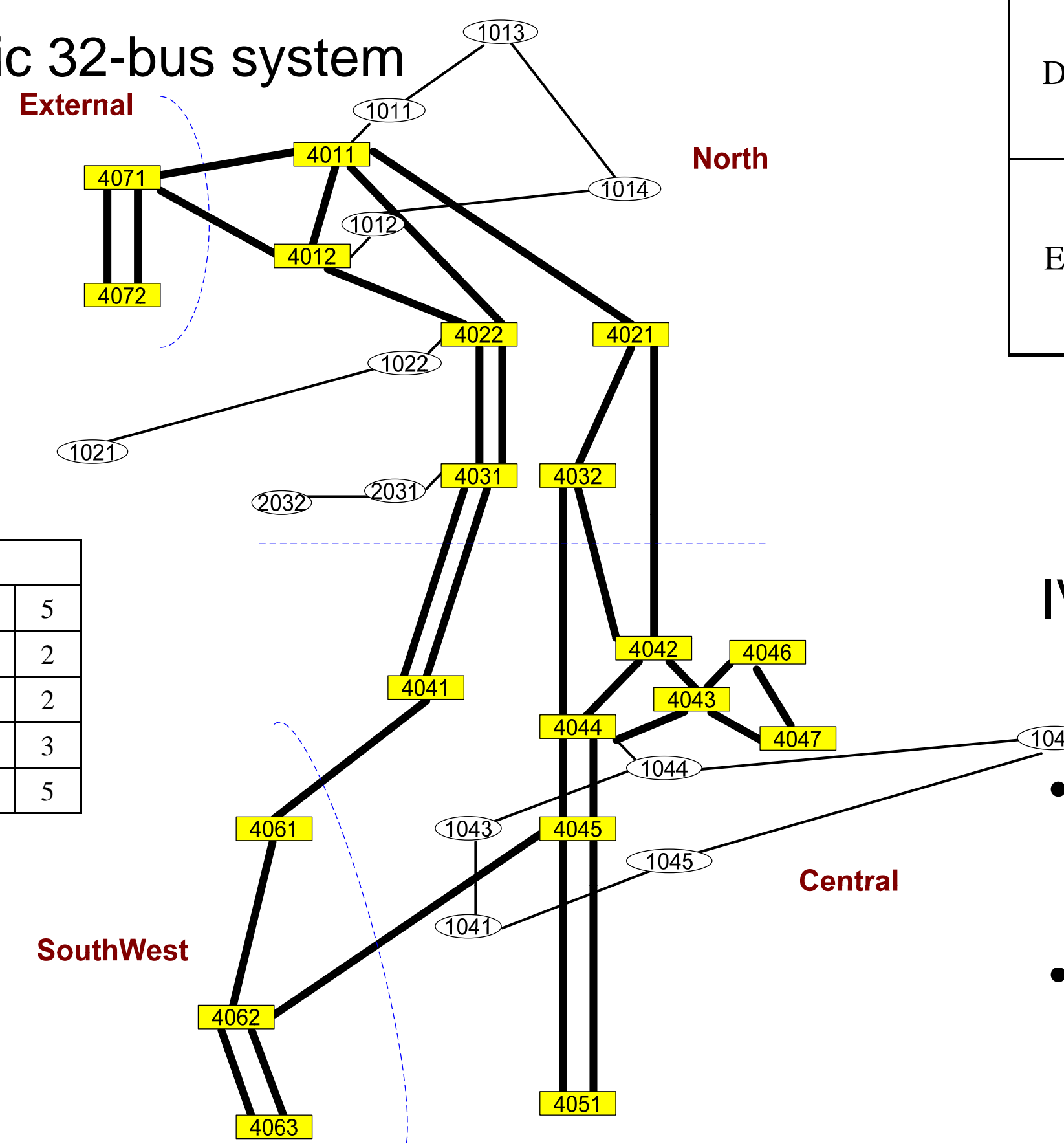
II. Real Options -- Inputs

- Present value of the underlying assets;
 - Refers to the expected present value of the project's future profits/losses.
- Uncertainty of the underlying assets' value.
- Cost for acquiring the underlying assets

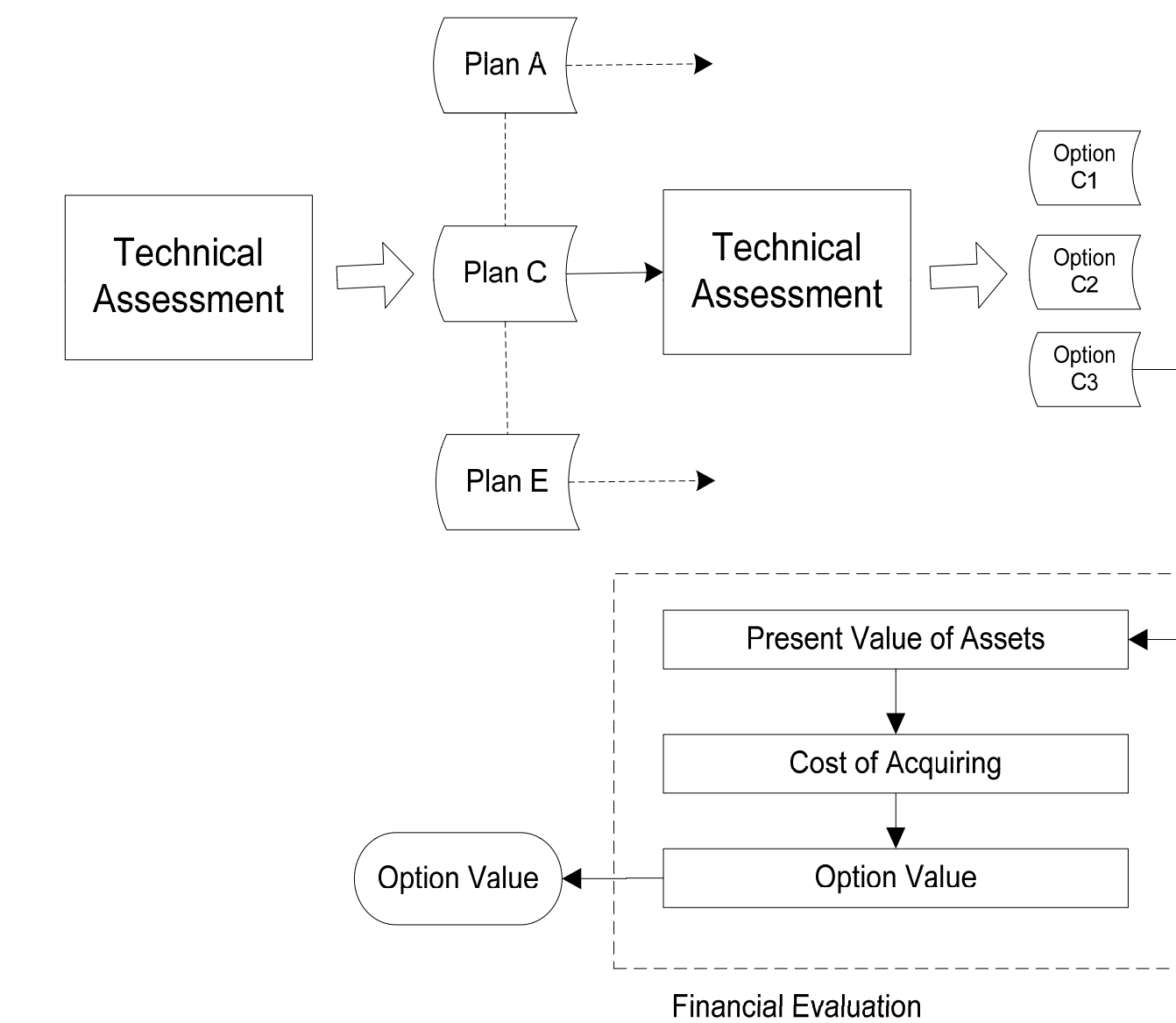


$$L = \sum_{t=1}^n \frac{I \cdot P_{En}}{(1+r)^{T+(t-1)/2}}$$

III. Example Case -- Nordic 32-bus system



Bus	Voltage (KV)	Year (%)				
		1	2	3	4	5
4071,4072	400	2	2	2	2	2
2031,2032	220	2	2	2	2	2
41-43,61-63,10**	130	3	3	3	3	3
46-47, 51	130	5	5	5	5	5



	As implemented	Options	Add Lines	Corresponding EIC (M\$/yr)
A	4061-4062 & 4021-4042	Option A1	4011-4021 & 4031-4032	9.468
		Option A2	4012-4022 & 4031-4032	9.215
		Option A3	4022-4031 & 4031-4032	9.376
B	4022-4031 & 4062-4061	Option B1	4021-4032	9.020
		Option B2	4031-4041	8.875
		Option B3	4031-4032 & 4032-4042	8.941
C	4011-4021 & 4061-4062	Option C1	4021-4042	8.988
		Option C2	4021-4032 & 4032-4042	8.745
		Option C3	4021-4032 & 4032-4044	8.653
D	4011-4022 & 4061-4062	Option D1	4031-4041 & 4022-4031	9.258
		Option D2	4011-4021 & 4021-4042	9.316
		Option D3	4031-4032 & 4021-4042	9.487
E	4012-4022 & 4061-4062	Option E1	4031-4041 & 4011-4012	9.484
		Option E2	4011-4021 & 4021-4042	9.366
		Option E3	4031-4032 & 4022-4031 & 4032-4042	9.257

IV. Conclusion

- The focus of the proposed model is to utilize ROA instead of NPV for financial evaluation.
- The overall value of each plan is the sum of near future's cost/benefits and long-term potential expansion options values.