

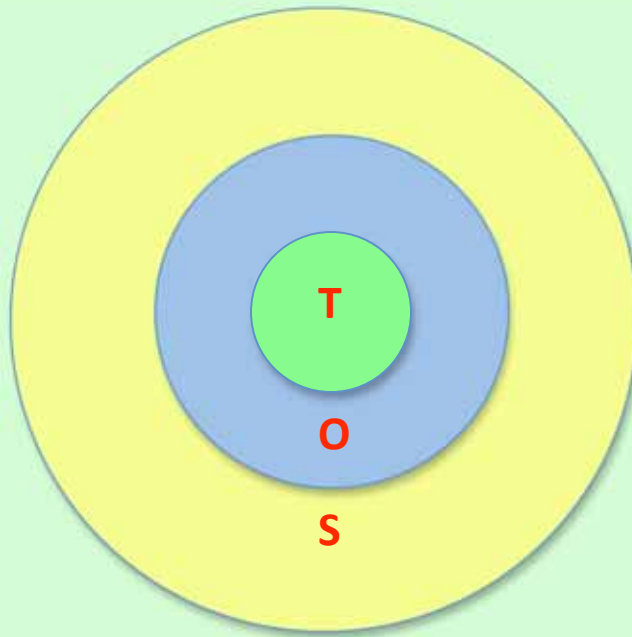
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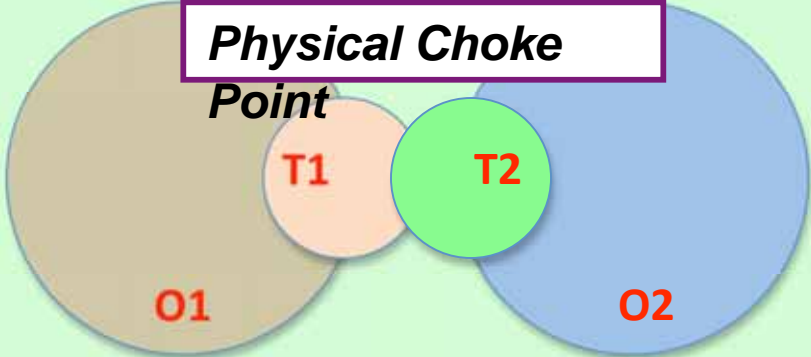
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Multiple Systems/Uses:

1. Electric Power Generation/Distribution
2. Water Distribution
3. Gas Distribution
4. Flood Control
5. Major Highways/Transportation
6. Housing/Communities
7. Commercial Agriculture
8. Commercial Fishing
9. Recreation
10. Environmental

All Technologies Are Embedded





Choke Points

1. Physical/Technical
2. Legal/Political
3. Social
4. Environmental
5. Management

A Zero-Sum Game?

	T separable	T integrated
O separable	Zero-sum	Impossible
O integrated	HRO	Systemic

Resilience

1. Legally
2. Managerially
3. Politically
4. Socially

Interactions

1. $O1 \rightarrow T1$
2. $O2 \rightarrow T2$
3. $T1 \rightarrow T2$ and/or $T2 \rightarrow T1$
4. $T1 \rightarrow O1$
5. $T2 \rightarrow O2$

Probability of Implication

Modus Ponens: $\{[O \ \& \ (O \rightarrow T)] \rightarrow T\}$

$$1. P[O \rightarrow T] = P[\text{not-}O \text{ or } T] = \\ P[\text{not-}O] + P[T] - P[\text{not-}O \ \& \ T];$$

but since $(\text{not-}O \ \& \ T)$ is identical to $\text{not-}(O \text{ or } \text{not-}T)$

$$2. P[O \rightarrow T] + P[O] = P[T \rightarrow O] + P[T]$$

Necessity Sufficiency

Probabilistic Modus Ponens

$$P[O \ \& \ O \rightarrow T] = P[O \rightarrow T] P[O/O \rightarrow T] = P[O] P[O \rightarrow T/O]$$

If we let $P[O/O \rightarrow T] = k_1 P[T]$, and

If we let, $P[O \rightarrow T/O] = k_2 P[T]$, then it can be shown that...

Probabilistic Modus Ponens

Substituting back into

$$P[O \rightarrow T] + P[O] = P[T \rightarrow O] + P[T]$$

$$1/k_1 + 1/k_2 = 1/k_1' + 1/k_2'$$