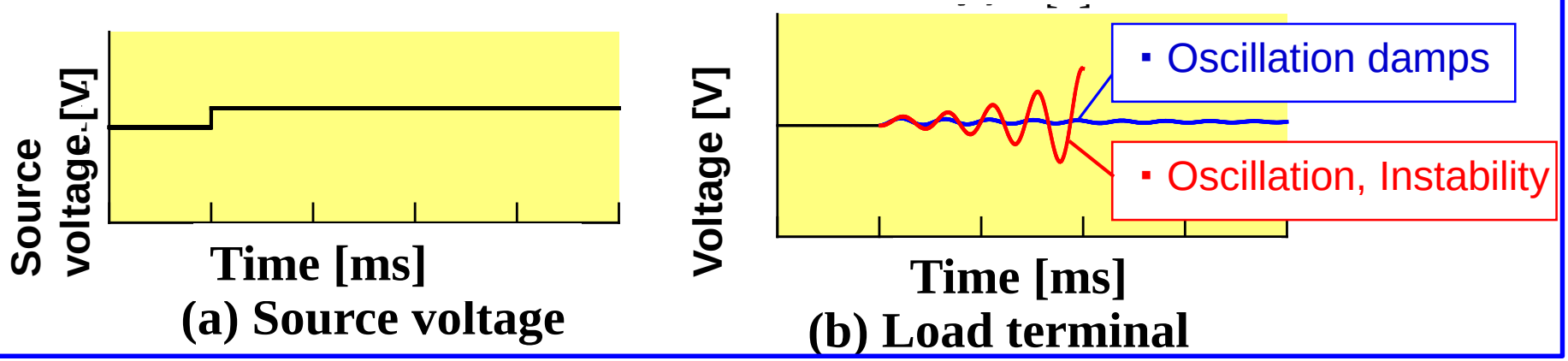
Power delivery property in DC distribution system

◆ A variety of facilities such as Internet Data Center attempt to deliver the electricity in the direct-current form.

◆ ・CIGRE (Conseil International des Grands Reseaux Electriques),
・IEEE,
・EPRI (Electric Power Research Institute)
and
・INTELEC (International Telecommunications Energy Conference)
have discussed installation of the DC distribution system.

・Elucidation of the various properties and phenomena
⟶ Upper limitation of deliverable power

◆ Voltage oscillation phenomenon at load terminal

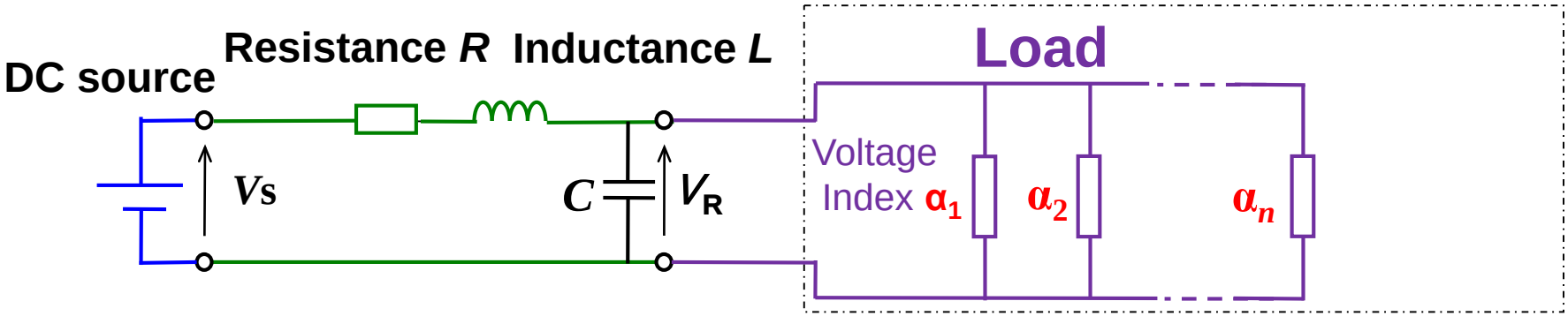


On the basis of these phenomena

(1) Discriminant was derived to judge whether phenomena occur or not

(2) Deliverable power was furthermore determined.

◆ DC delivery system in consideration of transient phenomena



(1) Application of Automatic control engineering.
Derivation of transfer function and characteristic equation.

Discriminant

$$A = -\frac{P_{\mathrm{lim,R}}(1-\alpha_{\mathrm{mix}})}{V_{\mathrm{R}}{}^{2}C} + \frac{R}{L}$$

$A \geq 0$: **Stable (Voltage converges.)**

$A < 0$: **Instable (Voltage never converges.)**

▪ *Load-terminal voltage oscillates for the voltage factor* α_{mix} less than 1, *depending on not only distribution constants (R, L, and C) but also the load power P*.

(2) The above procedures lead derivation of upper limitation of the deliverable power.

$$P_{\mathrm{lim,S}} = \frac{R}{(1-\alpha_{\mathrm{mix}})(L/C)+R^{2}} V_{\mathrm{S}}{}^{2}$$

▪ This expression corresponds to the steady-state stability in an AC delivery system.

Voltage factor for overall loads: $\alpha_{\mathrm{mix}} = \sum h_i \alpha_i = \sum \frac{p_i}{P_{\mathrm{sum}}} \alpha_i$