PTDFs

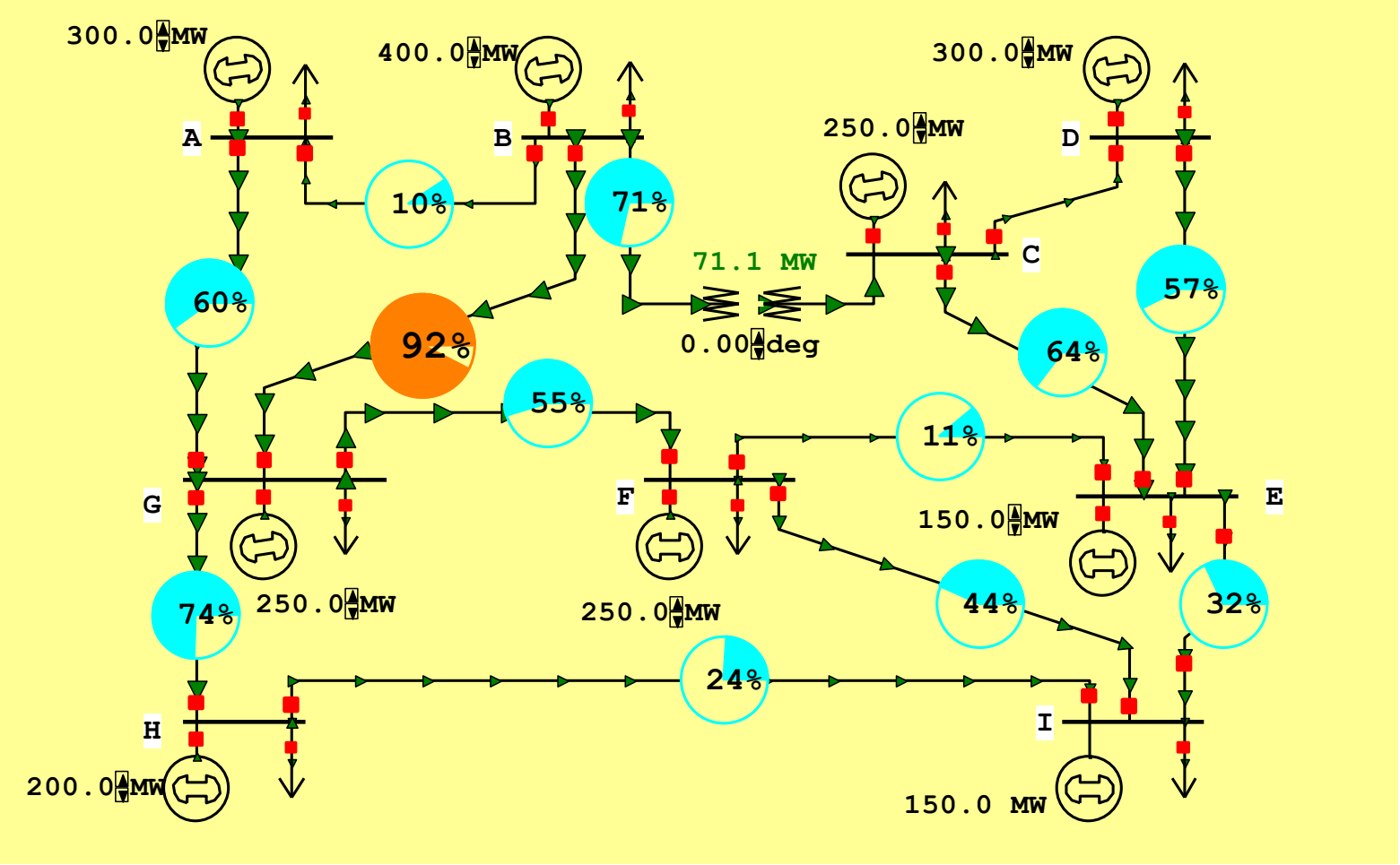
- Power transfer distribution factors (PTDFs) show the linearized impact of a transfer of power.
- PTDFs calculated using the fast decoupled power flow B matrix:

$$\Delta\boldsymbol{\theta} = \mathbf{B}^{-1}\Delta\mathbf{P}$$

Once we know $\Delta\boldsymbol{\theta}$ we can derive the change in the transmission line flows to evaluate PTDFs. Note that we can modify several elements in $\Delta\mathbf{P}$, in proportion to how the specified generators would participate in the power transfer.

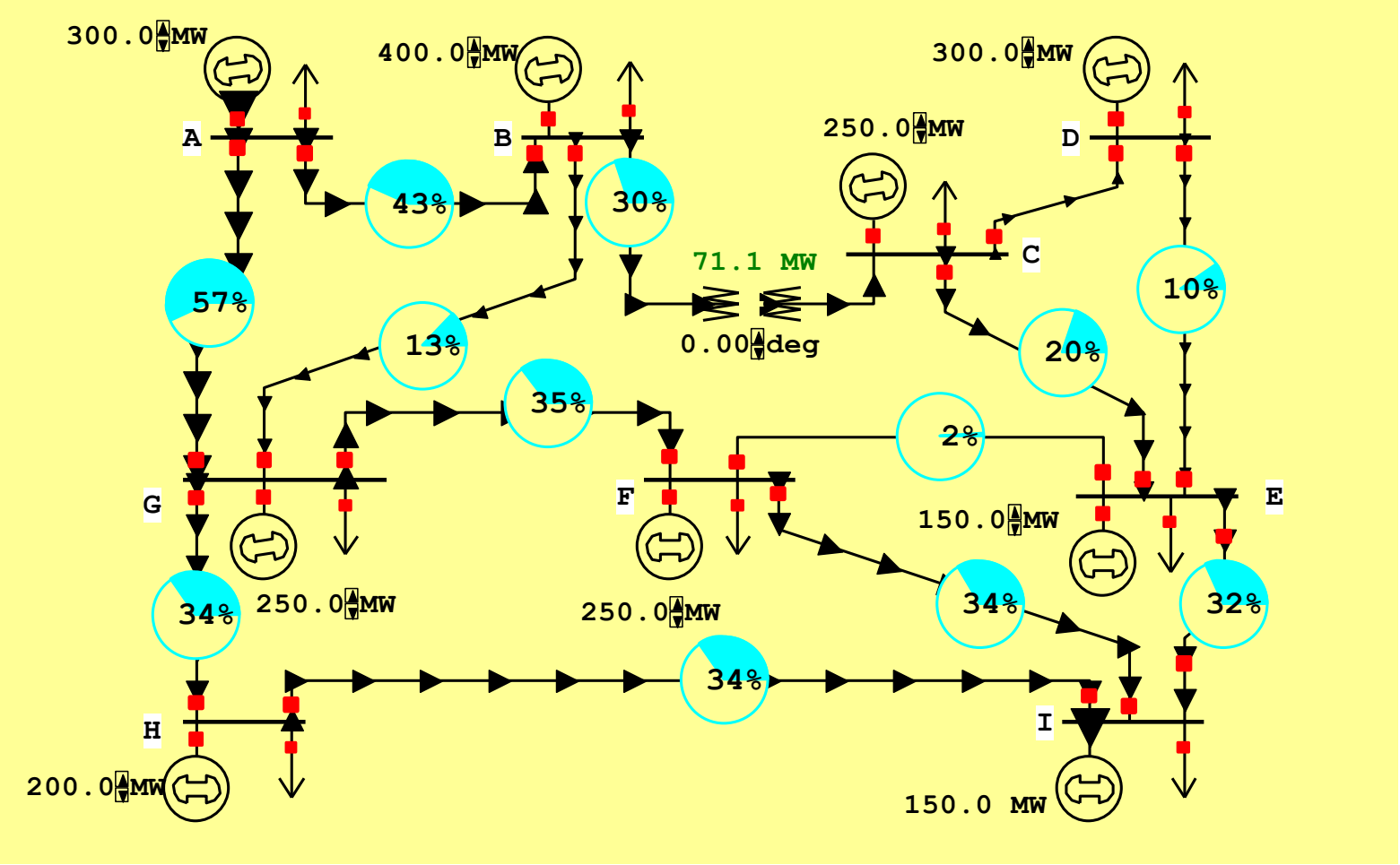
Nine Bus PTDF Example

Figure shows initial flows for a nine bus power system



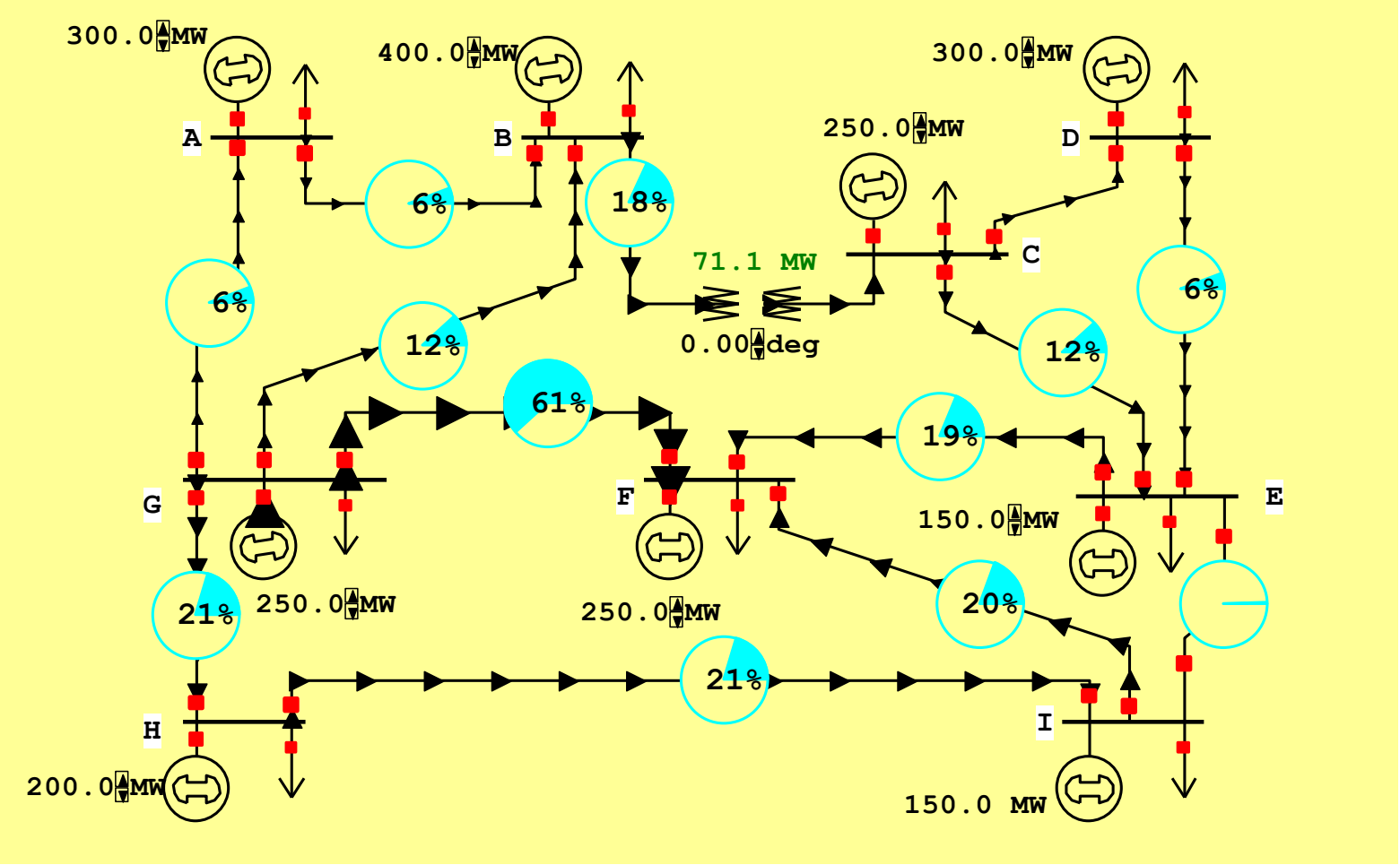
Nine Bus PTDF Example, cont'd

Figure now shows percentage PTDF flows for a change in transaction from A to I

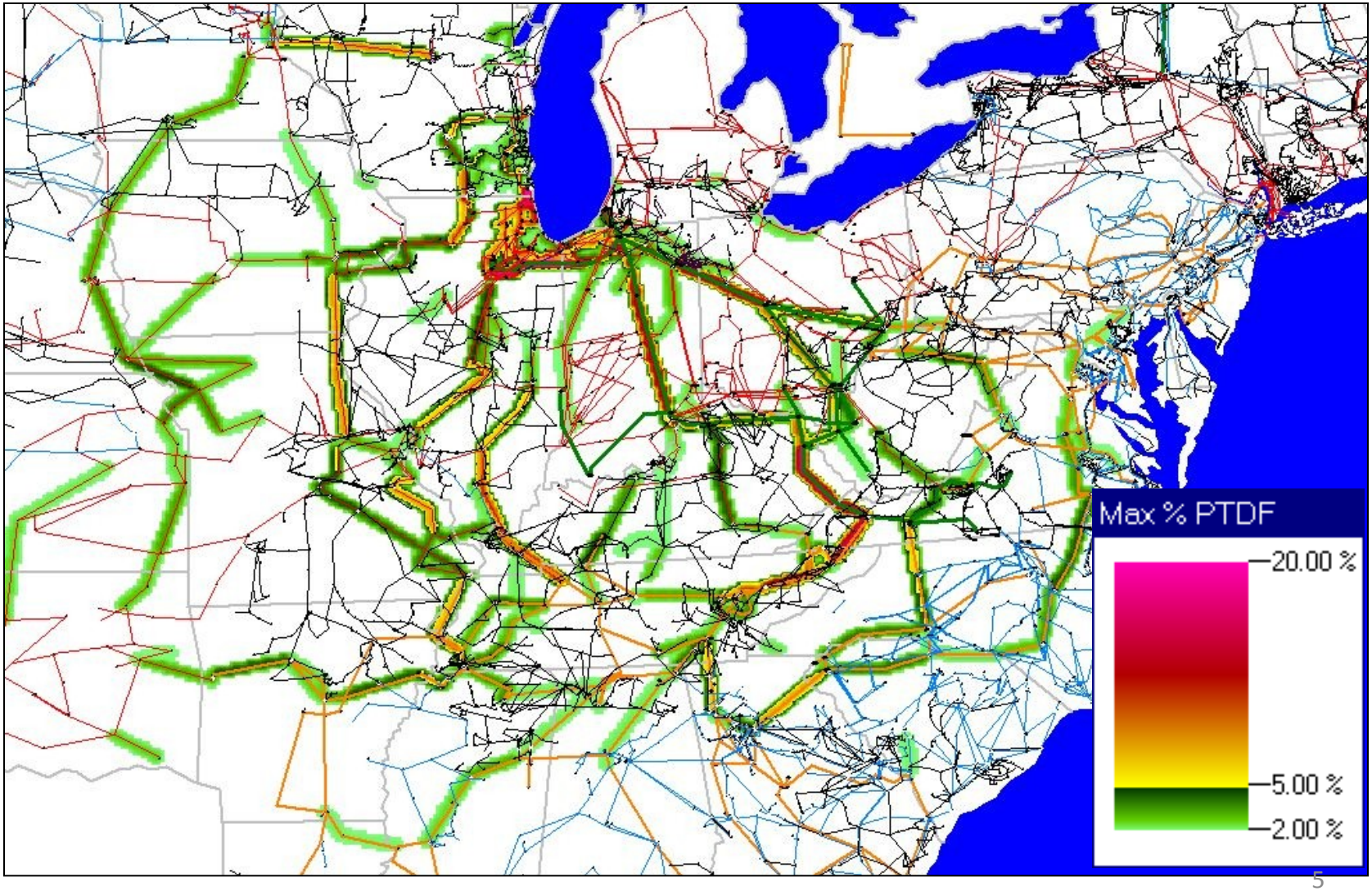


Nine Bus PTDF Example, cont'd

Figure now shows percentage PTDF flows for a change in transaction from G to F



WE to TVA PTDFs



Line Outage Distribution Factors (LODFs)

- LODFs are used to approximate the change in the flow on one line caused by the outage of a second line
  - typically they are only used to determine the change in the MW flow compared to the pre-contingency flow if a contingency were to occur,
  - LODFs are used extensively in real-time operations,
  - LODFs are approximately independent of flows but do depend on the assumed network topology.

Line Outage Distribution Factors (LODFs)

$\Delta P_l =$ change in flow on line l,

due to outage of line k.

$P_k =$ pre-contingency flow on line k

$\Delta P_l \approx LODF_{l,k}\, P_k$,

Estimates change in flow on line l

if outage on line k were to occur.

Line Outage Distribution Factors (LODFs)

If line k initially had $P_k = 100$ MW of flow on it,

and line l initially had $P_l = 50$ MW flow on it,

and then there was an outage of line k,

if $LODF_{l,k}$=0.1 then the increase in flow

on line l after a contingency of line k would be:

$$\Delta P_l \approx LODF_{l,k}\ P_k = 0.1 \times 100 = 10 \text{ MW}$$

from 50 MW to 60 MW.

Flowgates

- The real-time loading of the power grid can be assessed via “flowgates.”
- A flowgate “flow” is the real power flow on one or more transmission elements for either base case conditions or a single contingency
  - Flows in the event of a contingency are approximated in terms of pre-contingency flows using LODFs.
- Elements are chosen so that total flow has a relation to an underlying physical limit.

Flowgates

- Limits due to voltage or stability limits are often represented by effective flowgate limits, which are acting as “proxies” for these other types of limits.
- Flowgate limits are also often used to represent thermal constraints on corridors of multiple lines between zones or areas.
- The inter-zonal constraints that were used in ERCOT until December 2010 are flowgates that represent inter-zonal corridors of lines.