VOLTAGE SAG MITIGATION THROUGH DISTRIBUTION SYSTEM DESIGN

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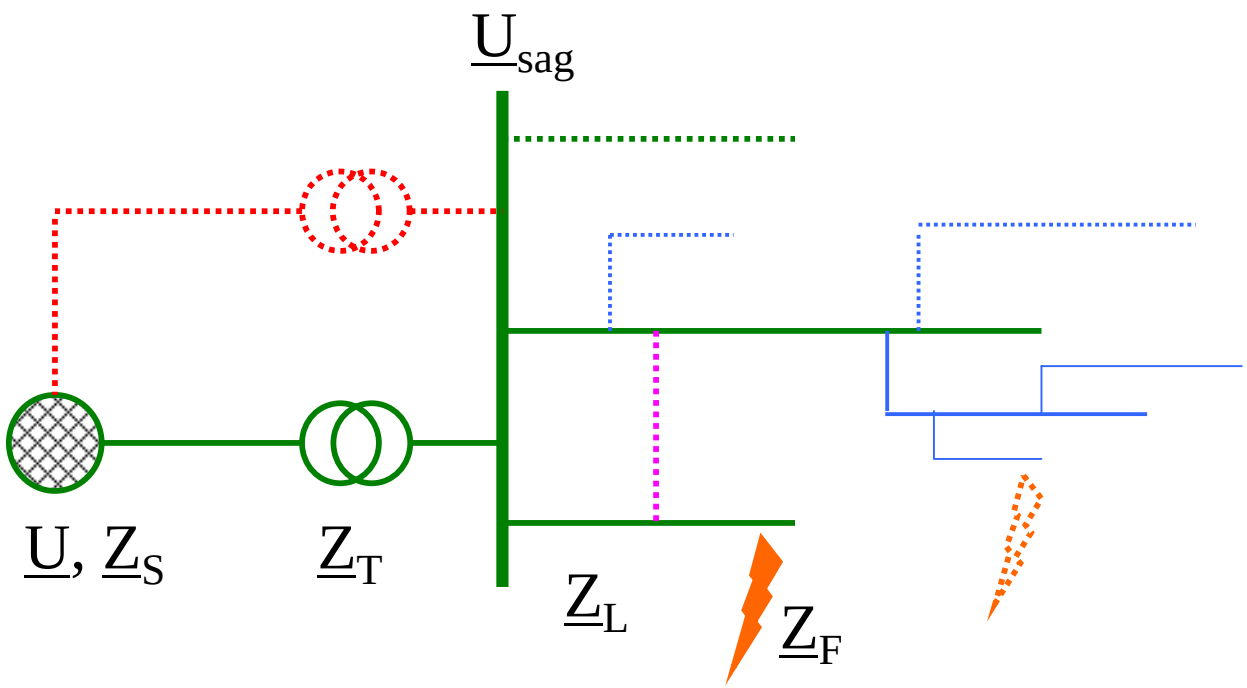
The possibilities for effecting the number of voltage sags



$$\underline{U}_{sag} = \frac{\underline{Z}_L + \underline{Z}_F}{\underline{Z}_S + \underline{Z}_T + \underline{Z}_L + \underline{Z}_F} \cdot \underline{U}$$

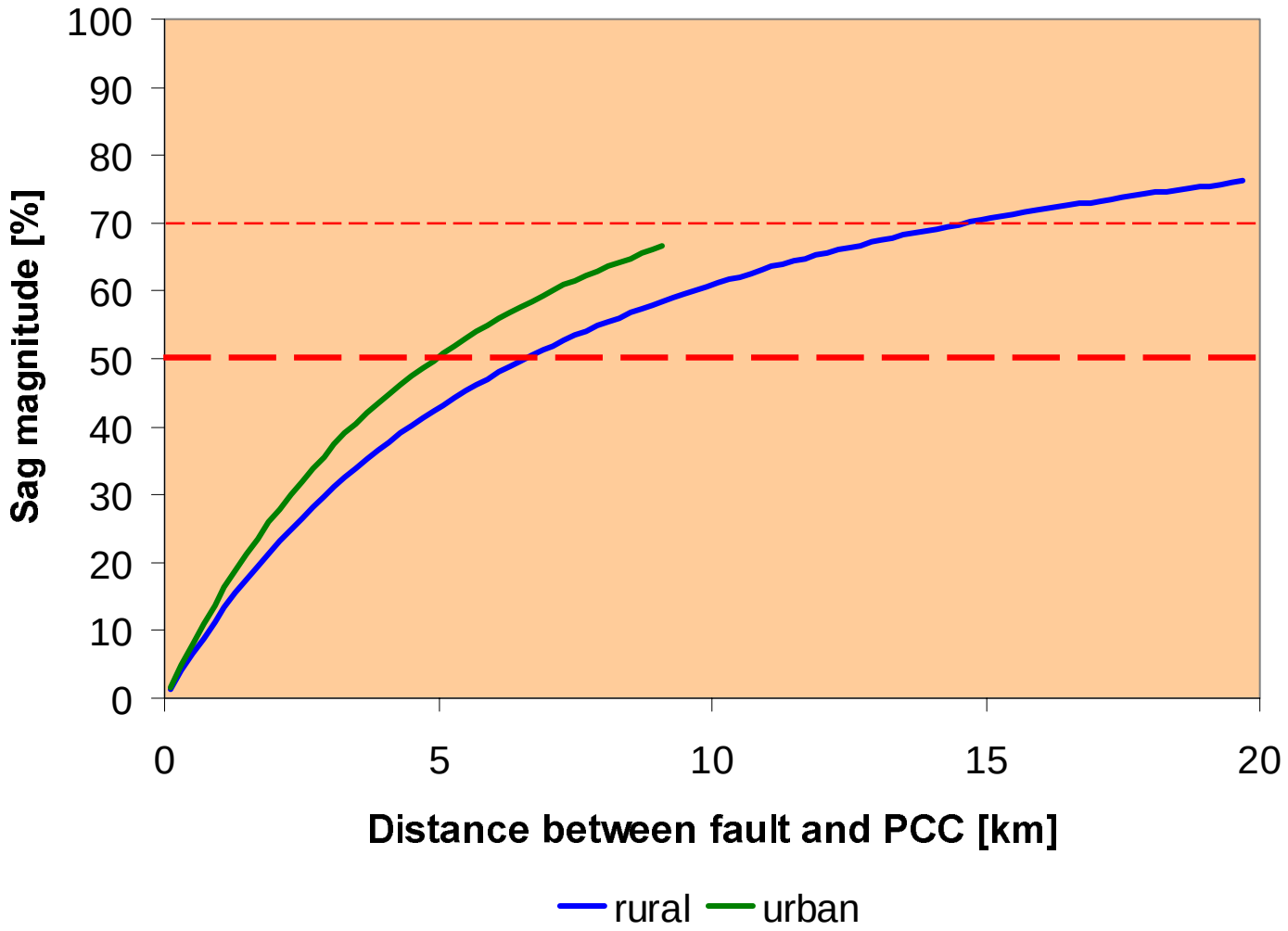
The feeders parallel to a sag sensitive customer's feeder should be considered:

- to limit the number and length of adjacent feeders (small substations)
- to have electrically as weak adjacent feeders as possible
- to prefer feeder branches far from PCC rather than close to it (feeder mass accumulates downstream and thus causes less problems at PCC)

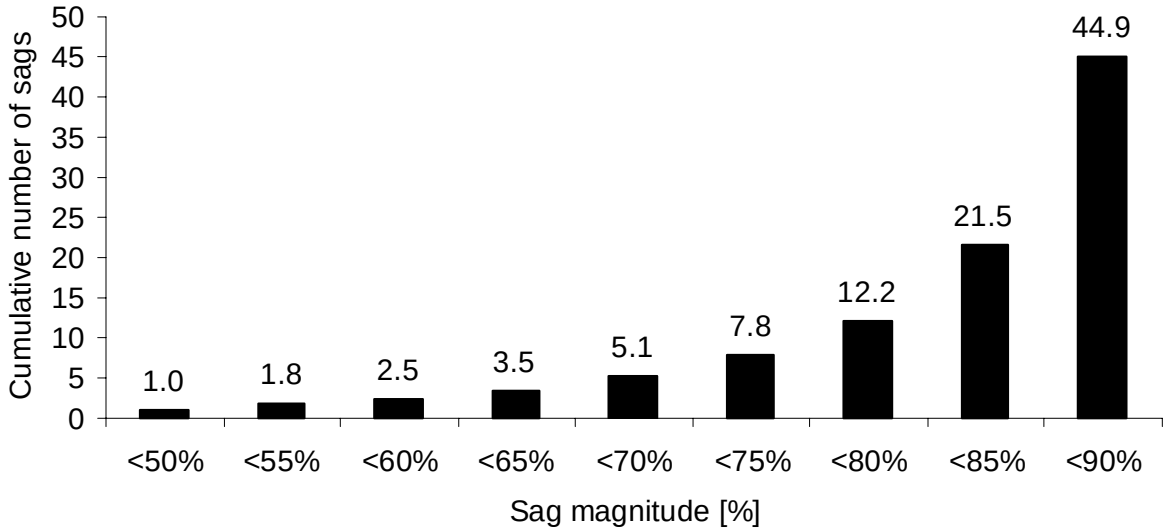
EXTERNAL CAUSES OF FAULTS LEADING TO AUTOCLOSURES AND SOME REMEDIES

CAUSE	REMEDY
LIGHTNING	o SHIELDING WIRES o ARC PROTECTORS FOR COVERED CONDUCTORS o SURGE ARRESTERS o RESONANT EARTHED SYSTEM
STORM	o SPACERS o DAMPERS
SNOW LOAD	o BIGGER MARGIN IN MECHANICAL DIMENSIONING OF LINES o COVERED CONDUCTORS
FOG	o SURGE ARRESTERS o INCREASED INSULATION o CLEANING OF SUBSTATION INSULATORS
FALLING TREES	o MAINTAINING OF THE WAYLEAVES OF LINES o COVERED CONDUCTORS
BIRDS	o SPARK GAPS EQUIPPED WITH INSULATING COVER o ANTI-BIRD RODS o SURGE ARRESTERS o COVERED CONDUCTORS

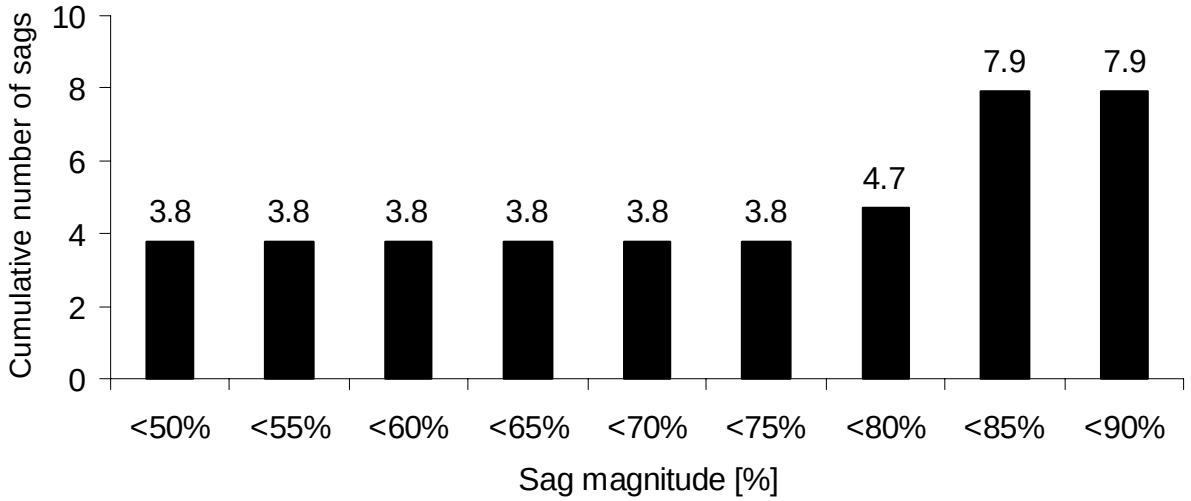
Sag magnitude as a function of the fault distance from PCC



Cumulative sag frequency as a function of sag magnitude

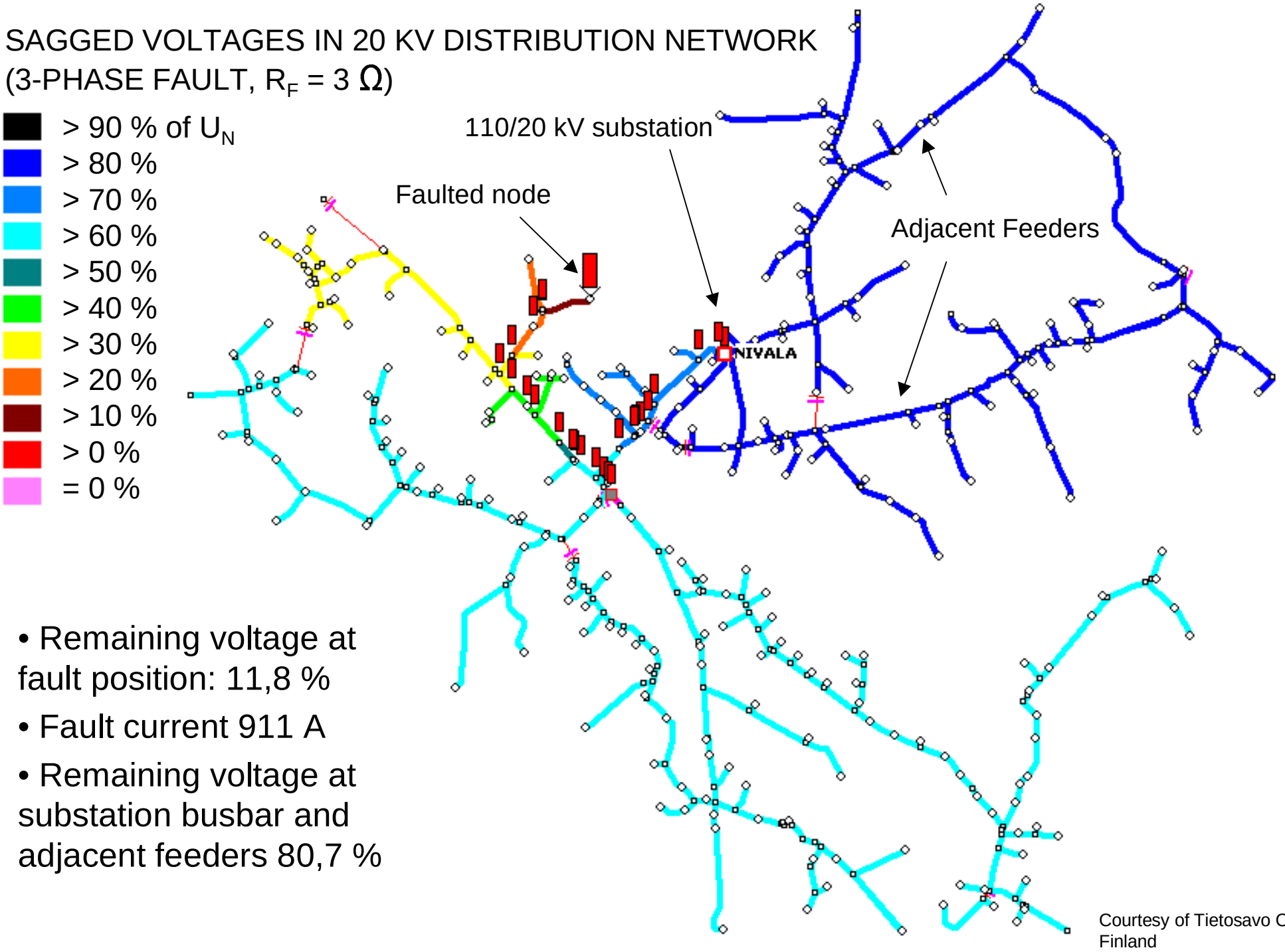


rural



urban

SAGGED VOLTAGES IN 20 KV DISTRIBUTION NETWORK
(3-PHASE FAULT, R_F = 3 Ω)

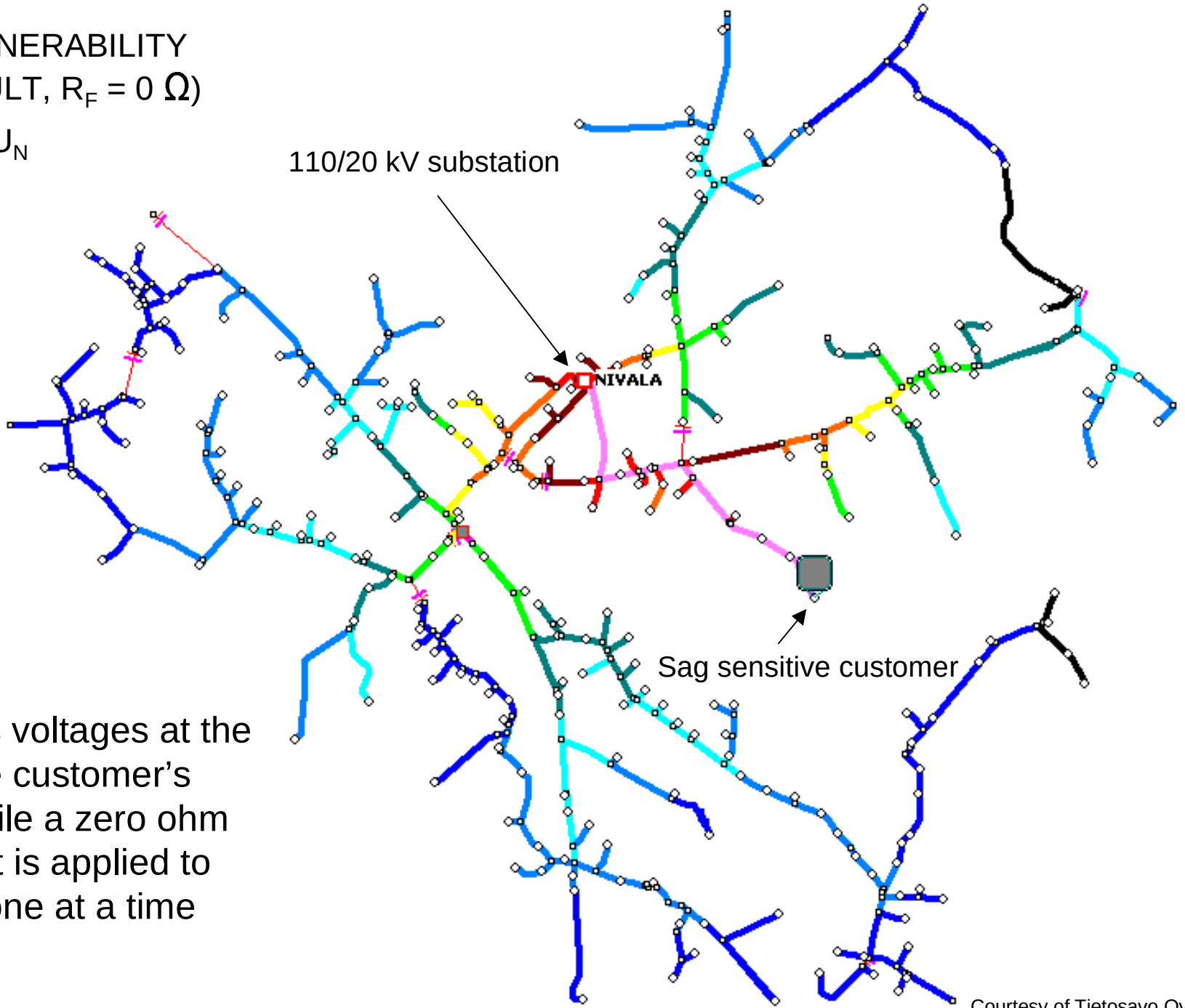


- Remaining voltage at fault position: 11,8 %
- Fault current 911 A
- Remaining voltage at substation busbar and adjacent feeders 80,7 %

Courtesy of Tietosavo Oyj
Finland

AREA OF VULNERABILITY
(3-PHASE FAULT, R_F = 0 Ω)

- > 90 % of U_N
- > 80 %
- > 70 %
- > 60 %
- > 50 %
- > 40 %
- > 30 %
- > 20 %
- > 10 %
- > 0 %
- = 0 %



• Represents voltages at the sag sensitive customer's terminals while a zero ohm 3-phase fault is applied to each node, one at a time

Courtesy of Tietosavo Oyj
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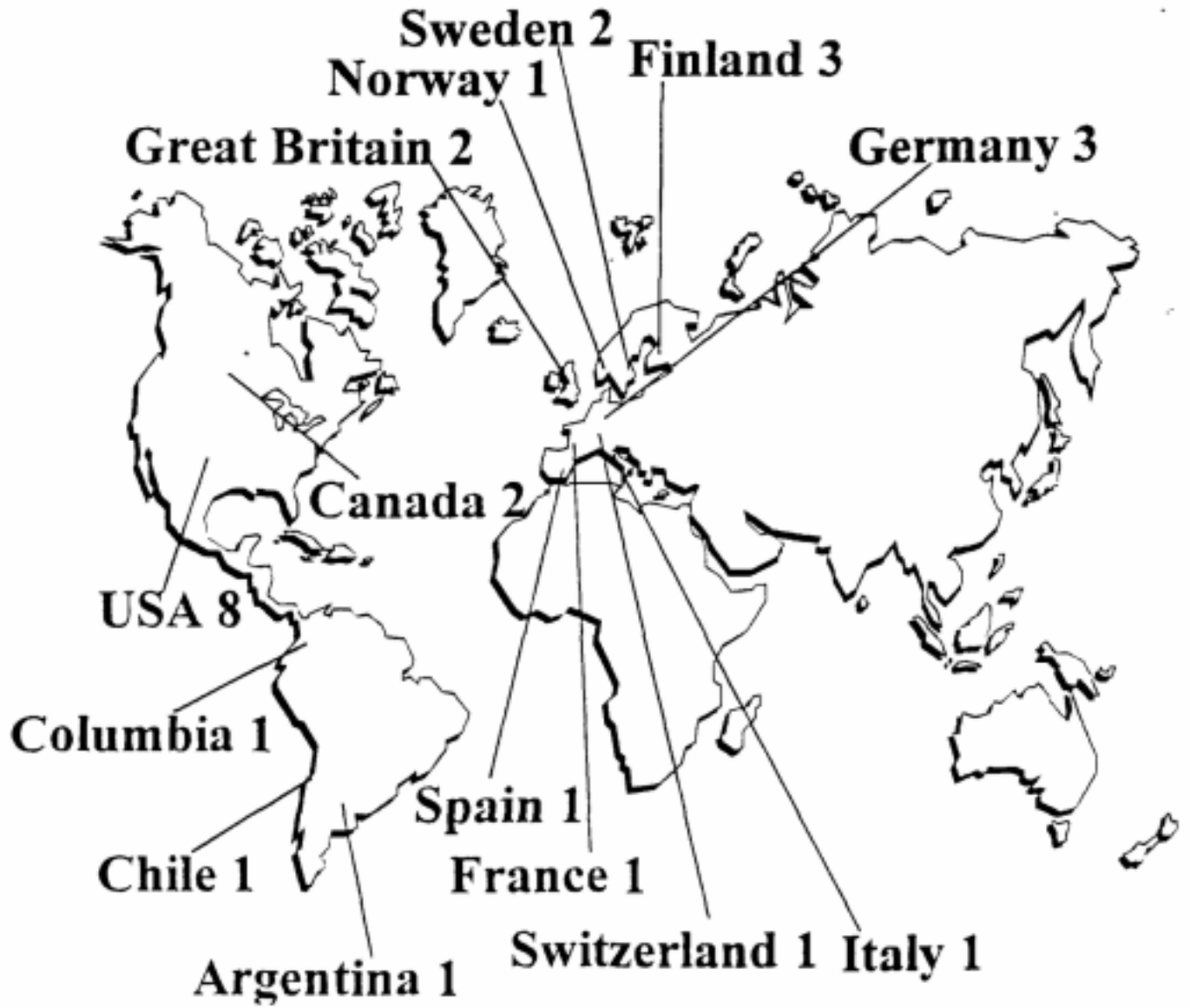

Origin of commercial AM/FM-GIS software