ESF II projekt Západočeské univerzity v Plzni

reg. č. CZ.02.2.69/0.0/0.0/18_056/0013239



EVROPSKÁ UNIE
Evropské strukturální a investiční fondy
Operační program Výzkum, vývoj a vzdělávání

MINISTERSTVO ŠKOLSTVÍ
MLÁDEŽE A TĚLOVÝCHOVY

FACULTY OF ELECTRICAL ENGINEERING
UNIVERSITY OF WEST BOHEMIA

Network configurations

Miloslava Tesařová

University of West Bohemia
Department of Power Engineering

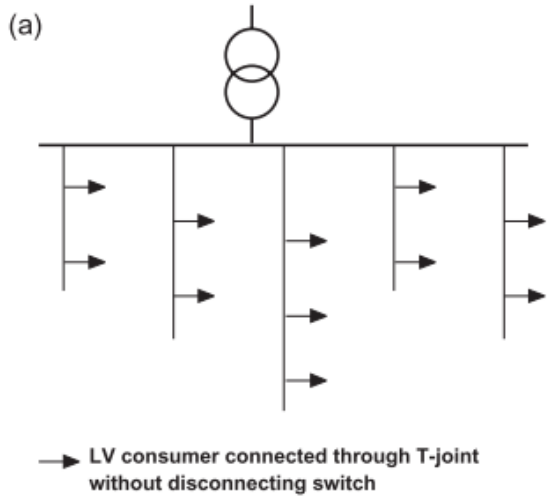
Update 10/2021

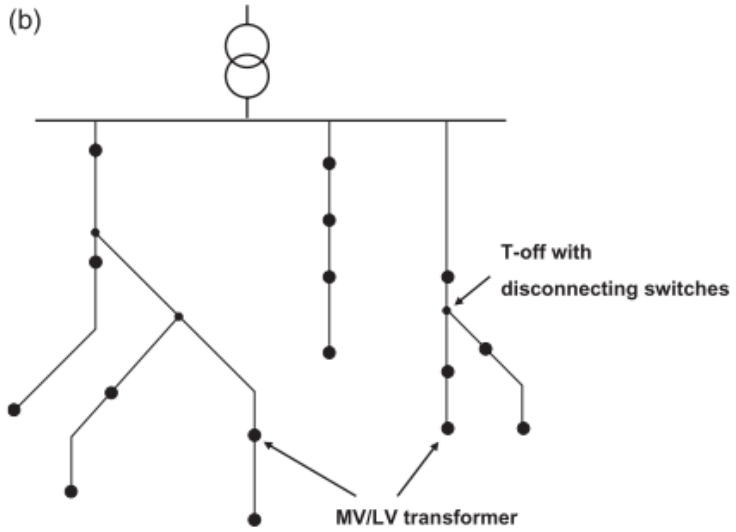
Power systems are constructed and operated as

- Radial systems
- Ring - main systems
- Meshed systems

Radial systems

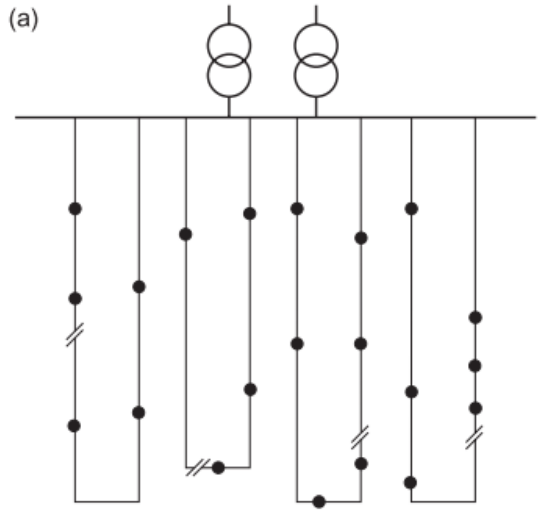
- the simplest system configuration
- LV and MV networks
- clear and simple structure
- low planning expenditure
- low investment cost
- no reserve for loss of lines
- loading of lines during normal operation up to 100%
- voltage profile not very good
- simple operation under normal operating conditions
- low short-circuit currents





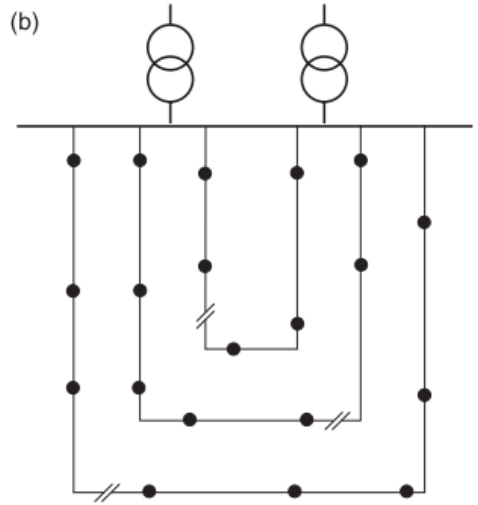
Ring - Main Systems

- mainly MV networks
- Clear and simple structure
- Moderate planning expenditure
- Simple operation (similar to radial system) under normal operating conditions
- Loading of lines during normal operation 50% of the permissible loading, higher loading possible depending on load duration
- Reserve for outage of each line section given by the line itself
- Investment cost not very high
- Voltage profi le can be optimized,
- Higher short-circuit currents



// Disconnection point (n.o.)

• MV/LV transformer connected through fuse or disconnecting switch

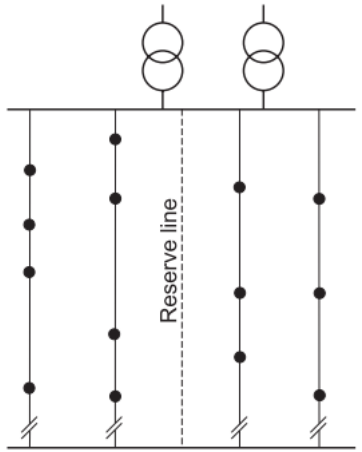


// Disconnection point (n.o.)

• MV/LV transformer connected through fuse or disconnecting switch

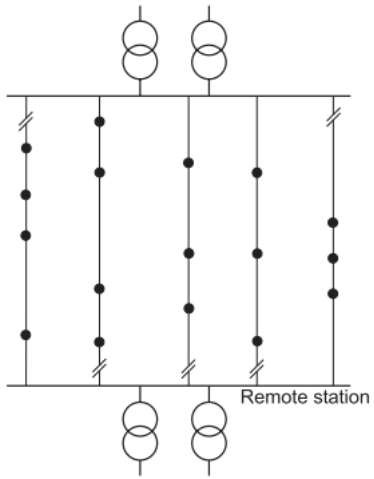
Ring - Main Systems

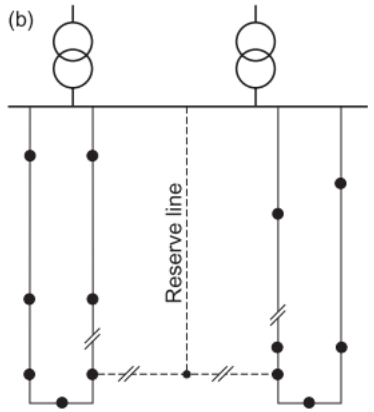
- Many modifications of ring systems



// Disconnection point (n.o.)

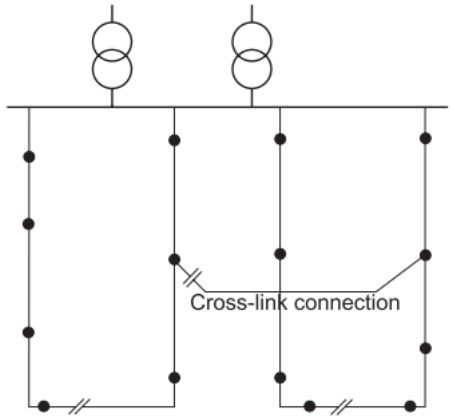
• MV/LV transformer connected through fuse or disconnecting switch





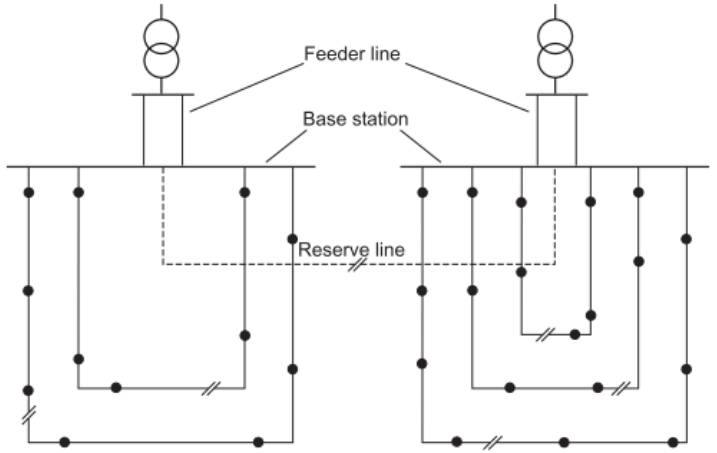
// Disconnection point (n.o.)

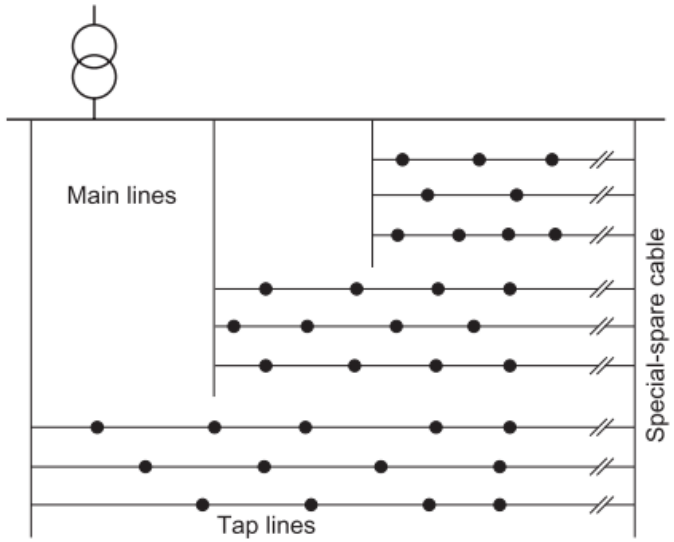
• MV/LV transformer connected through fuse or disconnecting switch



// Disconnection point (n.o.)

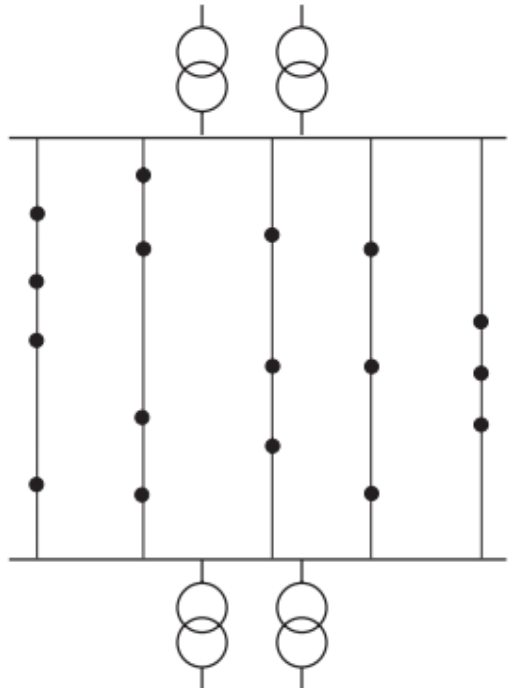
• MV/LV transformer connected through fuse or disconnecting switch

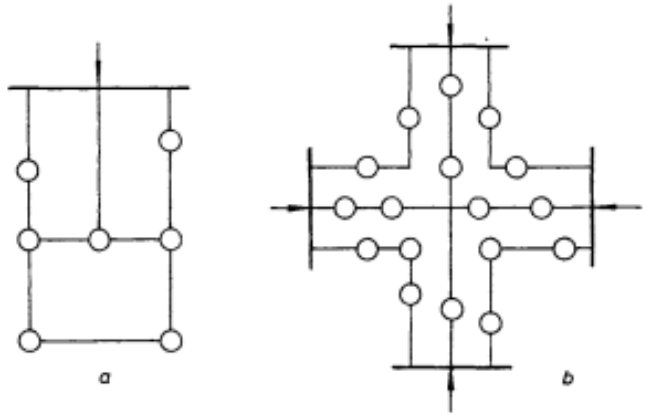




Meshed Systems

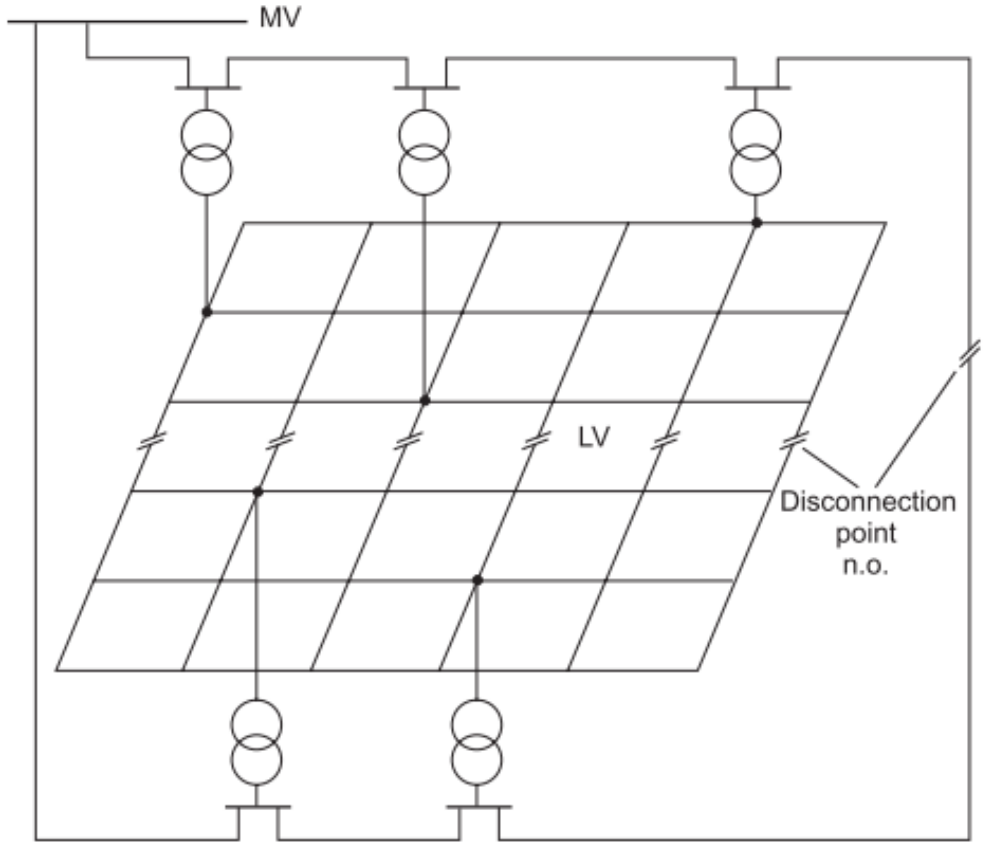
- mainly HV and EHV networks, but also MV and LV networks
- Complicated system structure
- High expenditure for system planning
- Reserve for outages according to planning criteria
- High investment cost
- High flexibility for changed load conditions
- No interruption of supply according to planning criteria
- High short-circuit currents
- Many modifications of ring systems

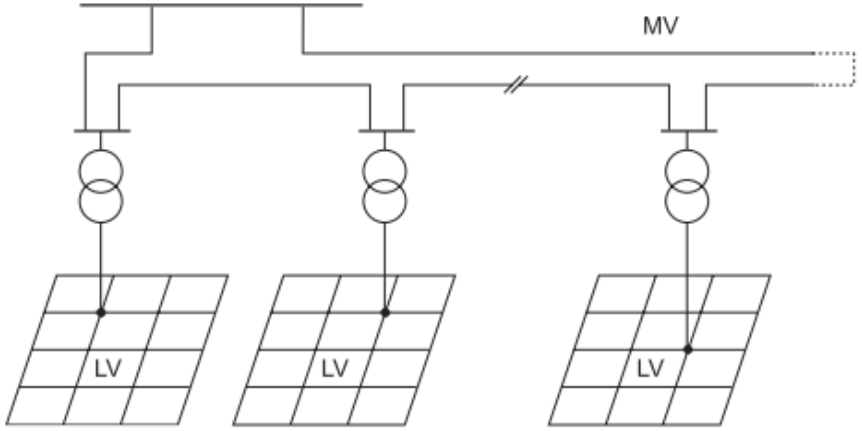


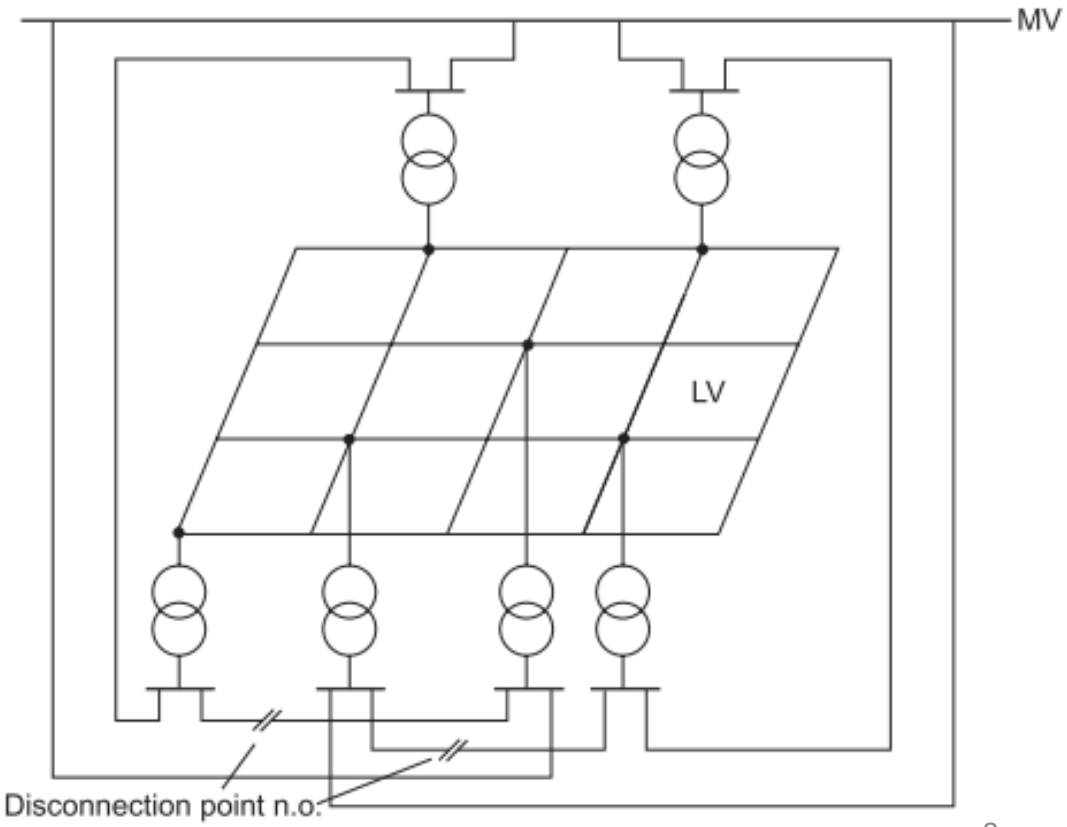


Meshed Systems

- different primary feeding

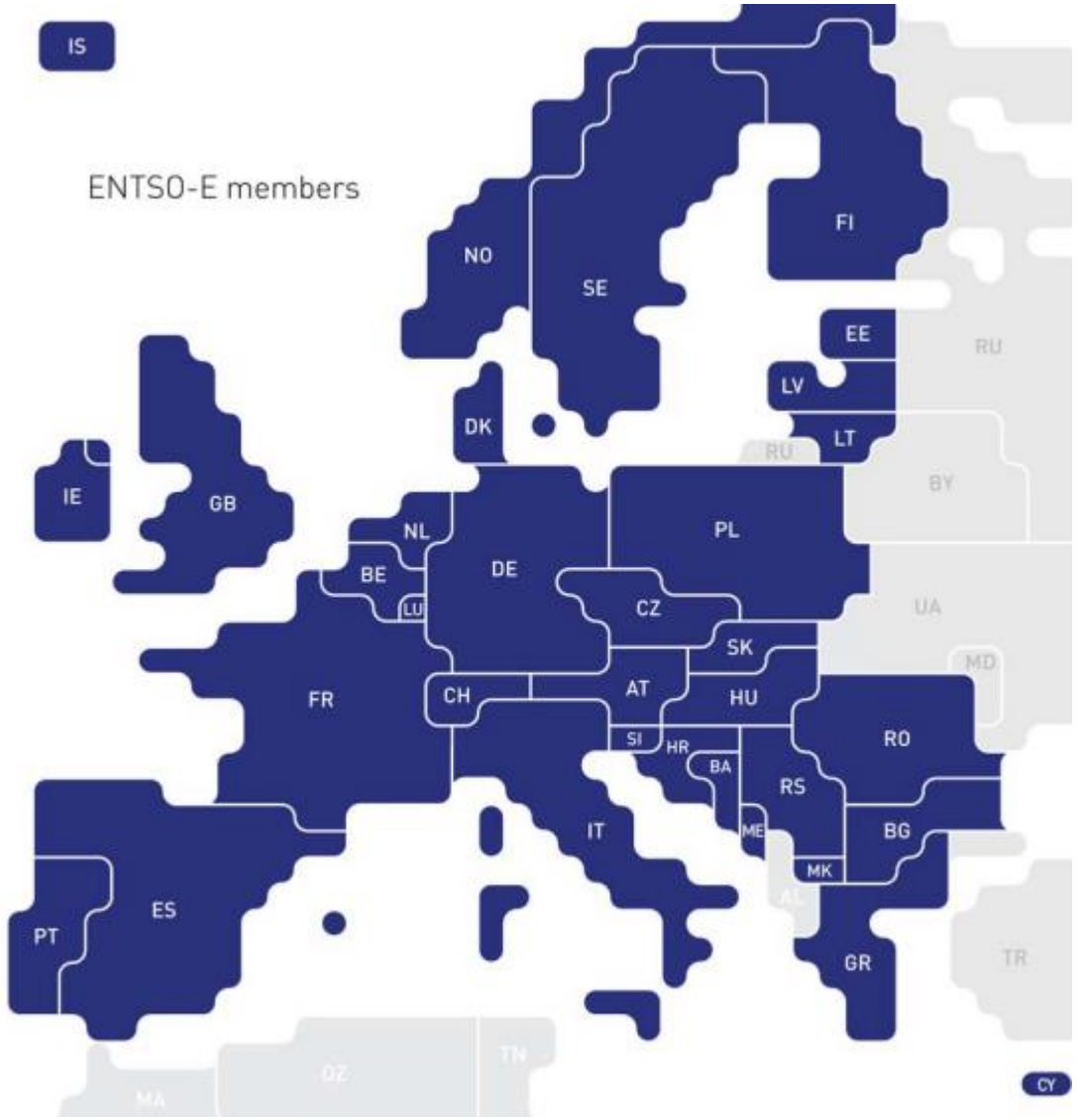


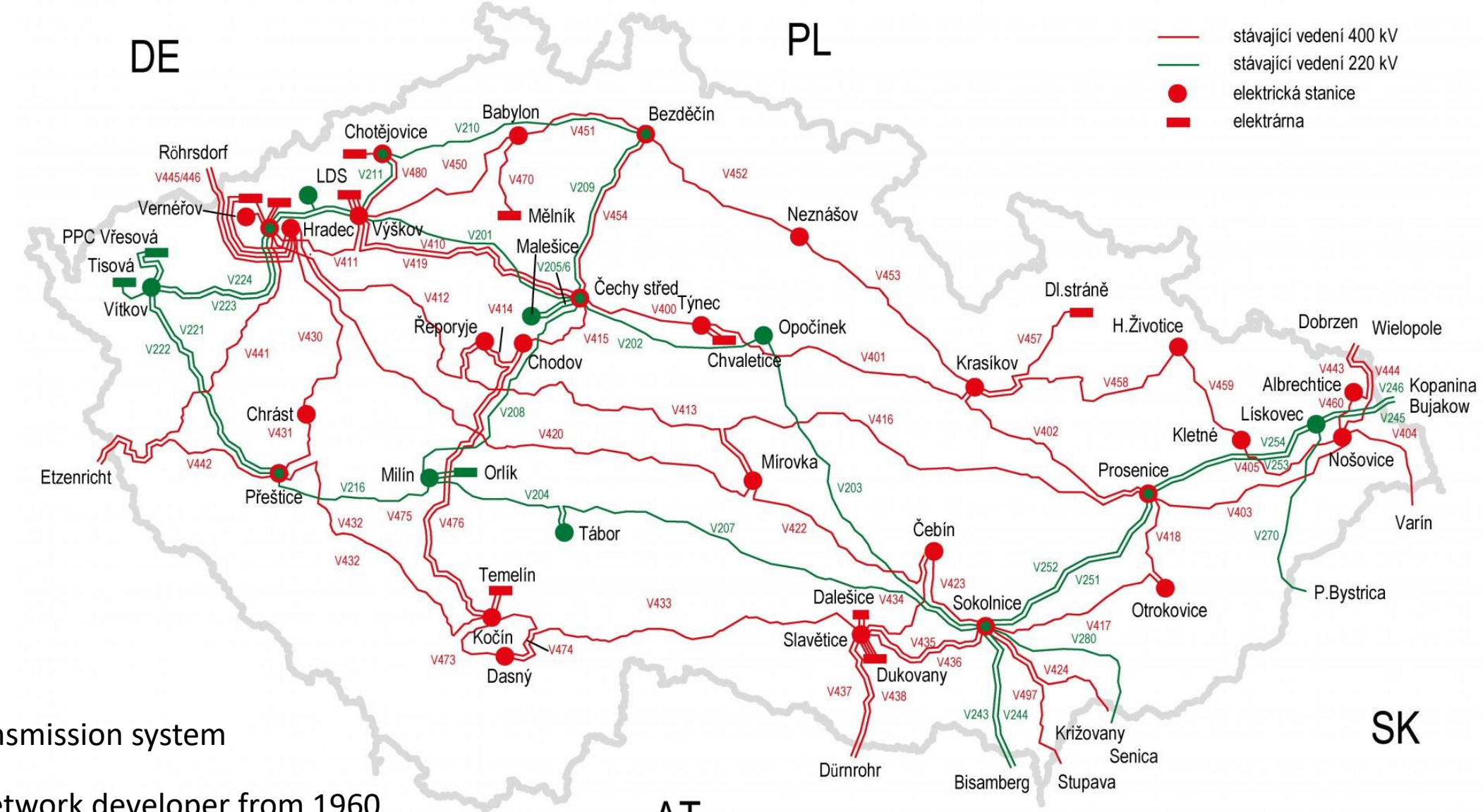




Transmission systems

- ENTSO-E
- HV and EHV networks



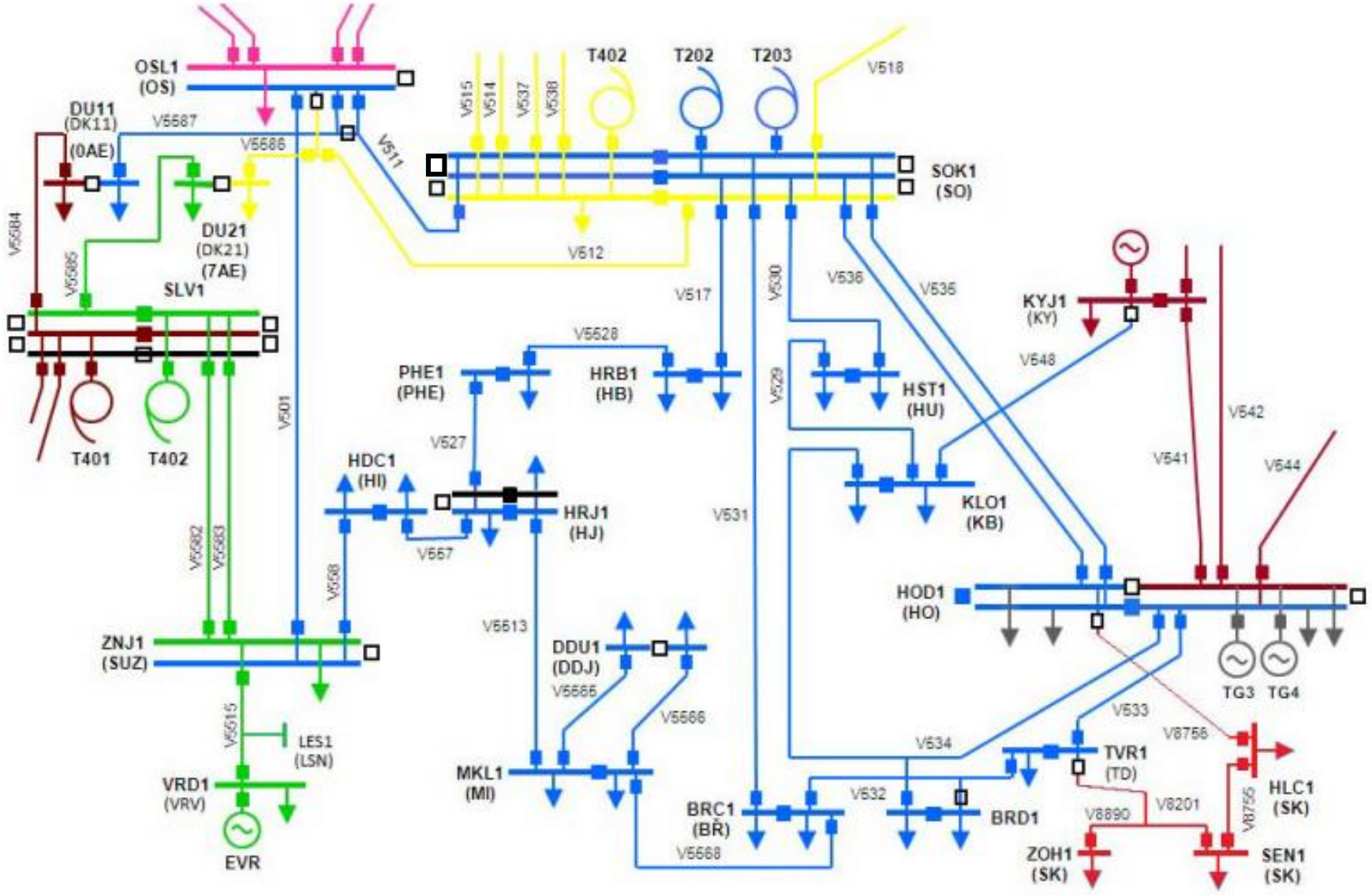


Czech transmission system

400 kV network developer from 1960
220 kV network developer in 1951-65

Zdroj: ČEPS

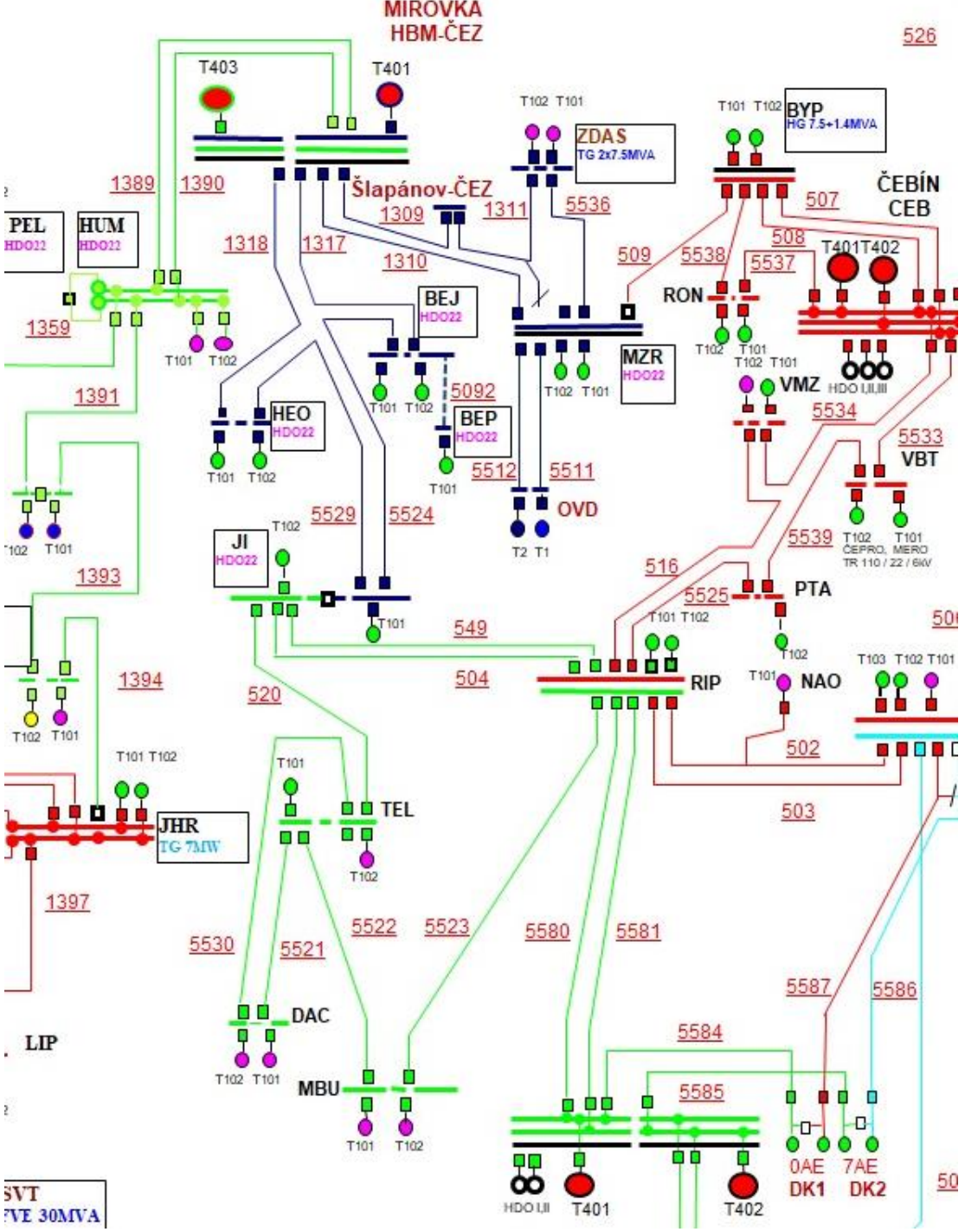
Transmission system – Meshed system



Zdroj: ČEPS

HV distribution system

- Meshed system



MV distribution system

Rural
overhead system

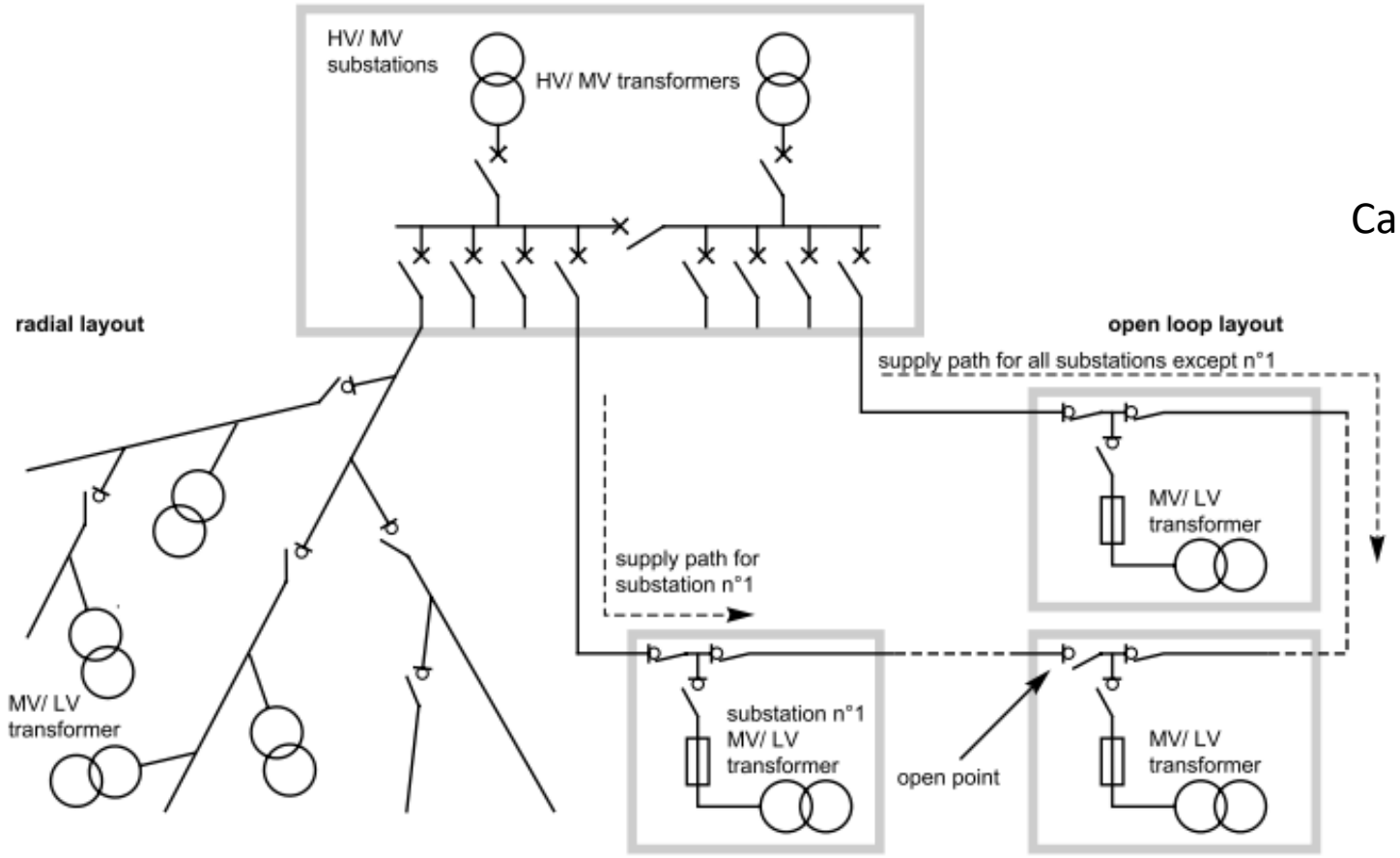
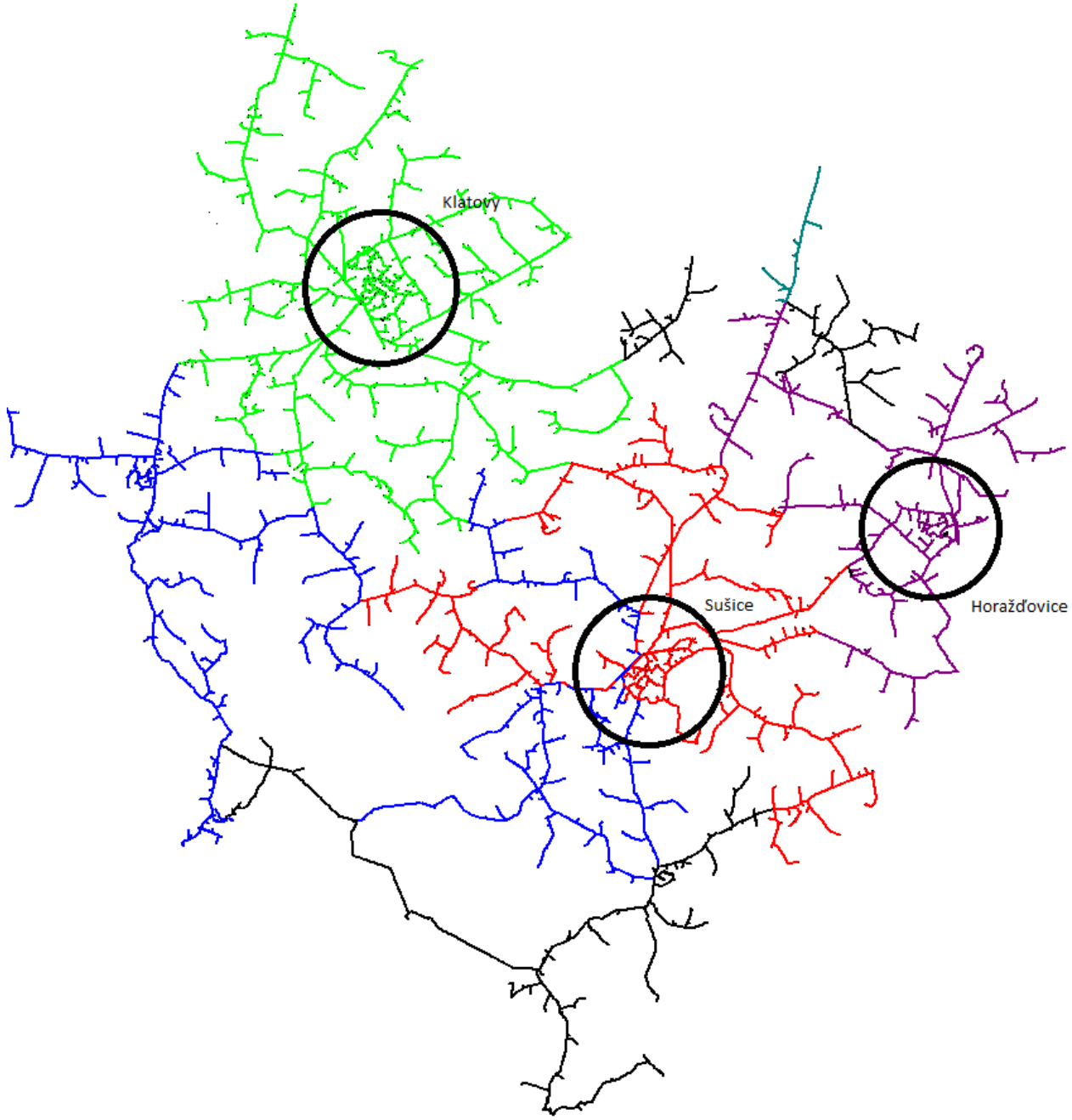


fig. 9: the two basic layouts of a MV distribution network, radial (or antenna) and open loop (or artery break).

Cable system in cities

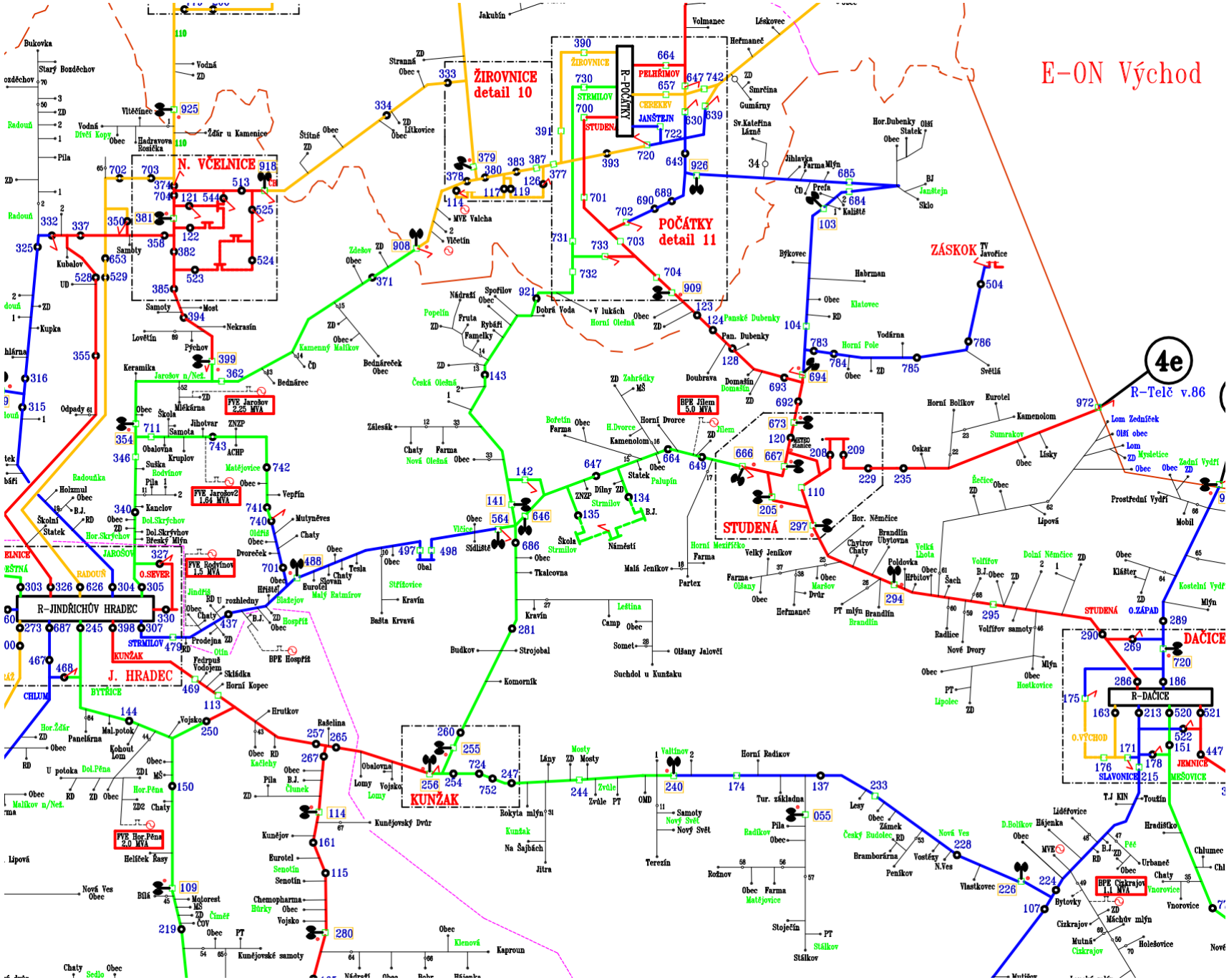
MV rural overhead system

- Meshed system divided by section switches on several meshed networks



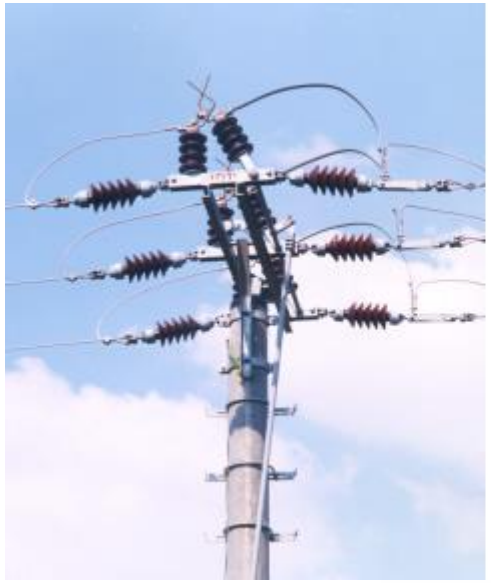
MV rural overhead system

- meshed configuration is changed by section switches on radial one



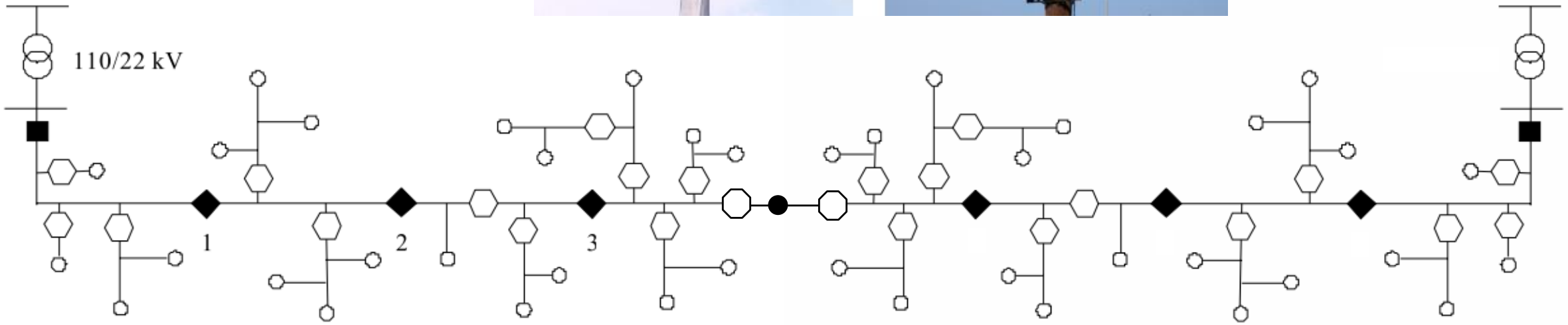
Section switches/disconnectors

Manually controlled





Remote controlled



■ Feeder circuit-breaker

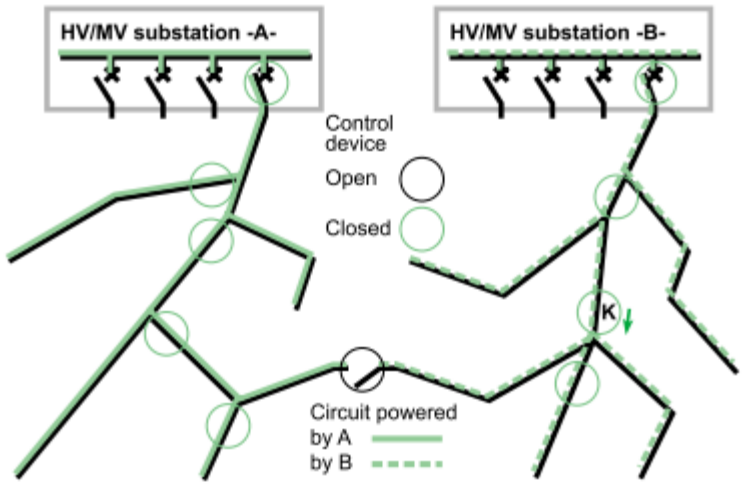
◆ Remote controled switch/disconnector

⬡ Manually controled switch/disconnector

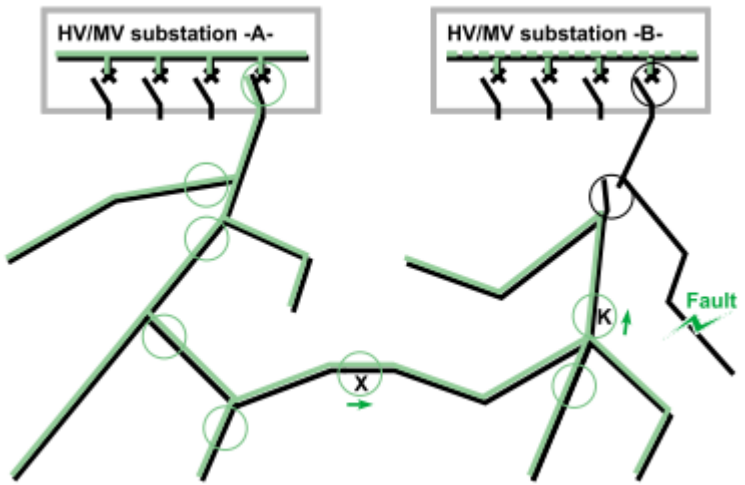
● Tie-switch (remote or manually controlled)

○ Distribution transformation station

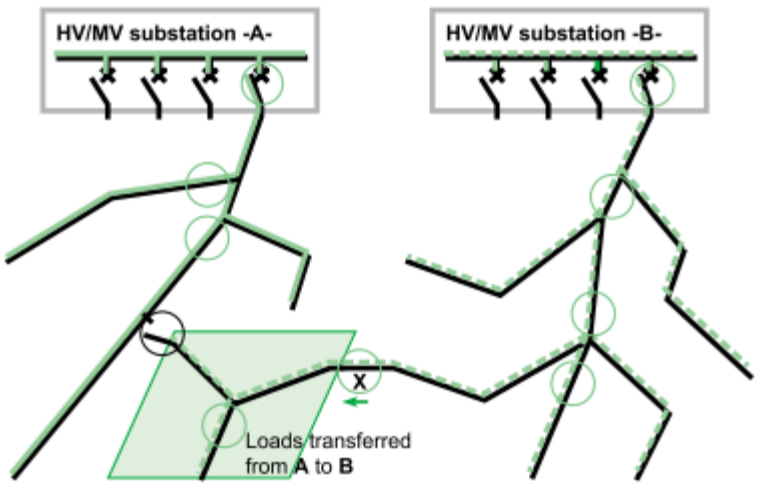
configuration for normal operation



configuration after an incident reducing the number of customers affected

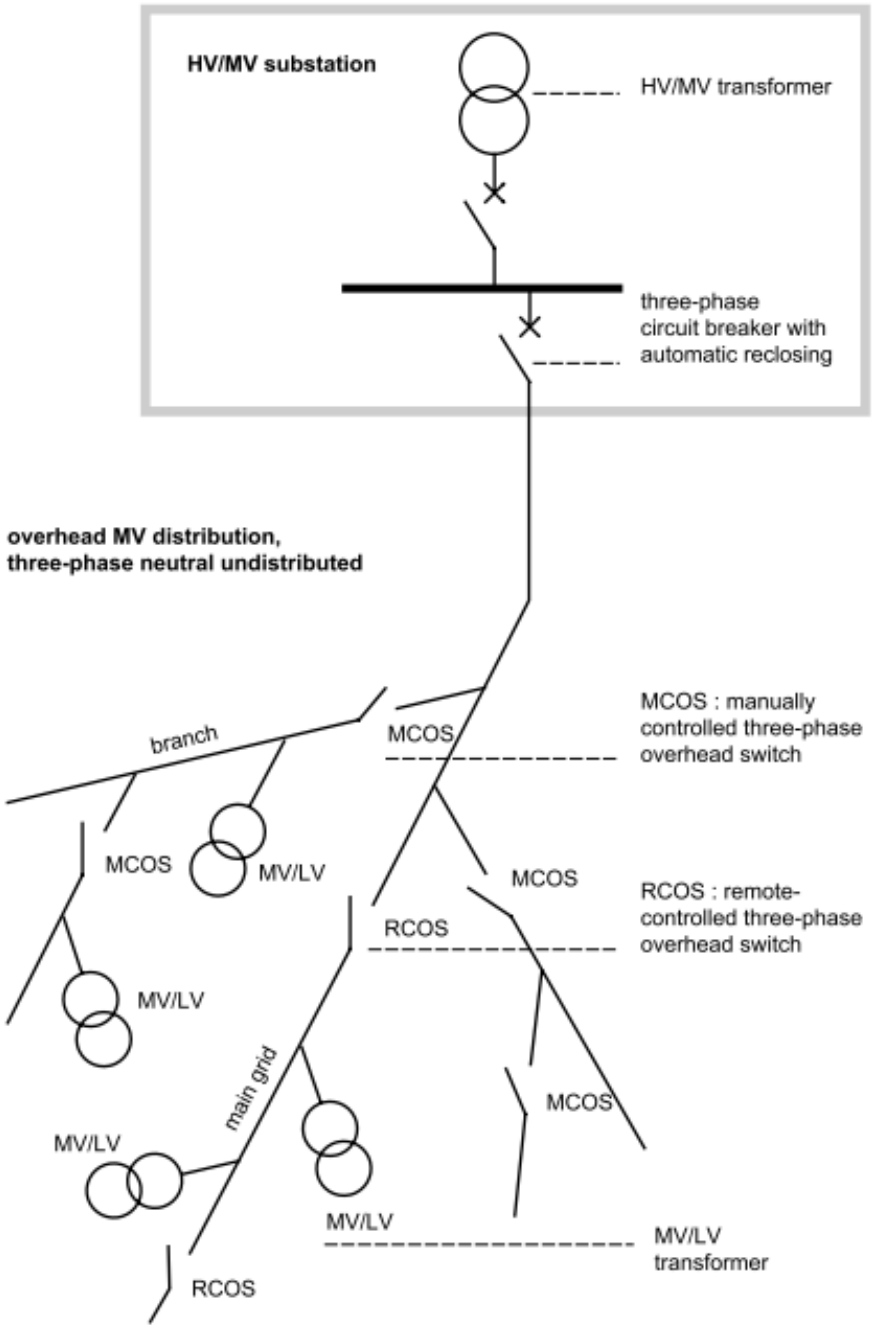


configuration for resupply with limitations on the load



MV overhead systems

Europe v. North America



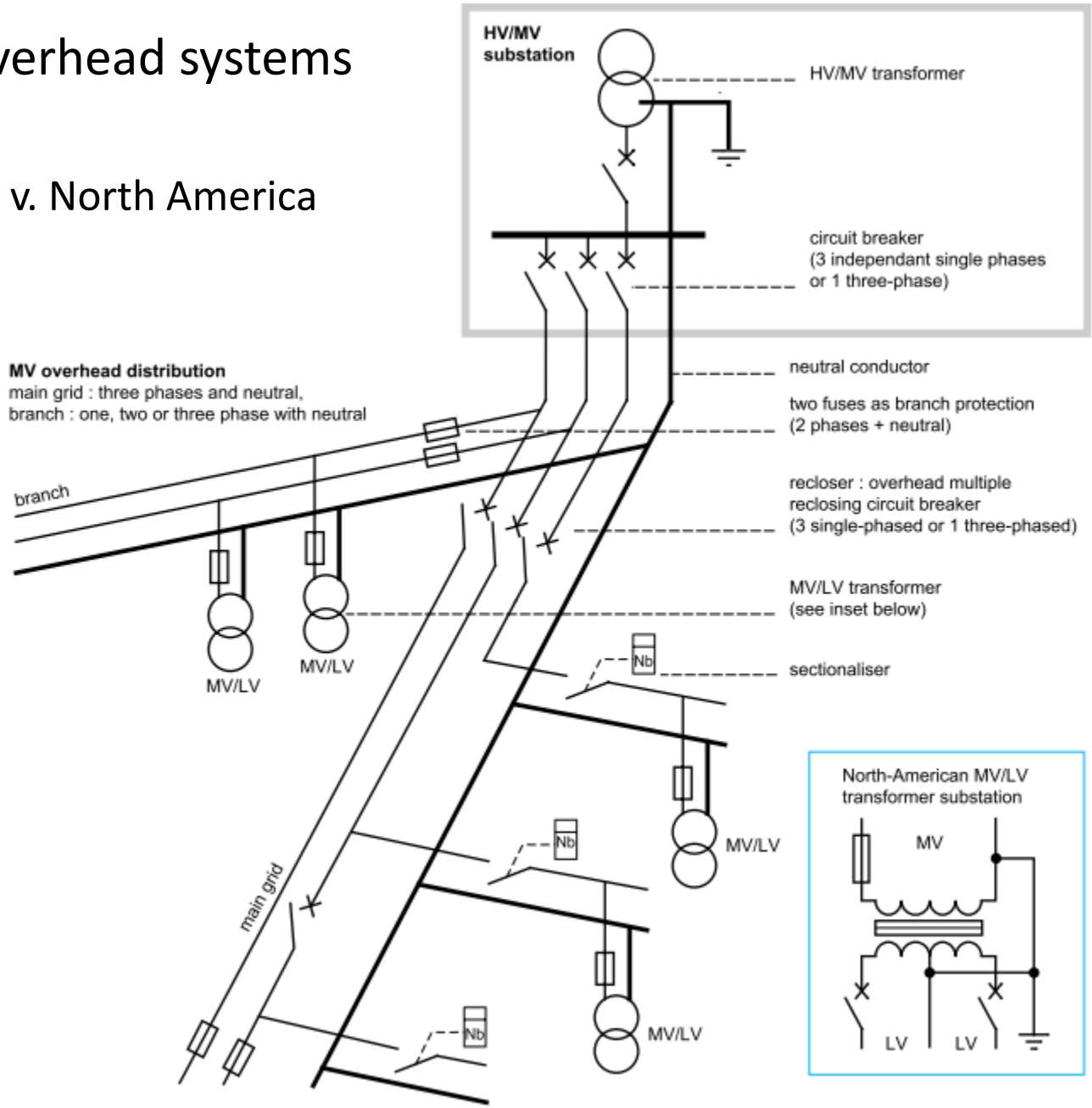
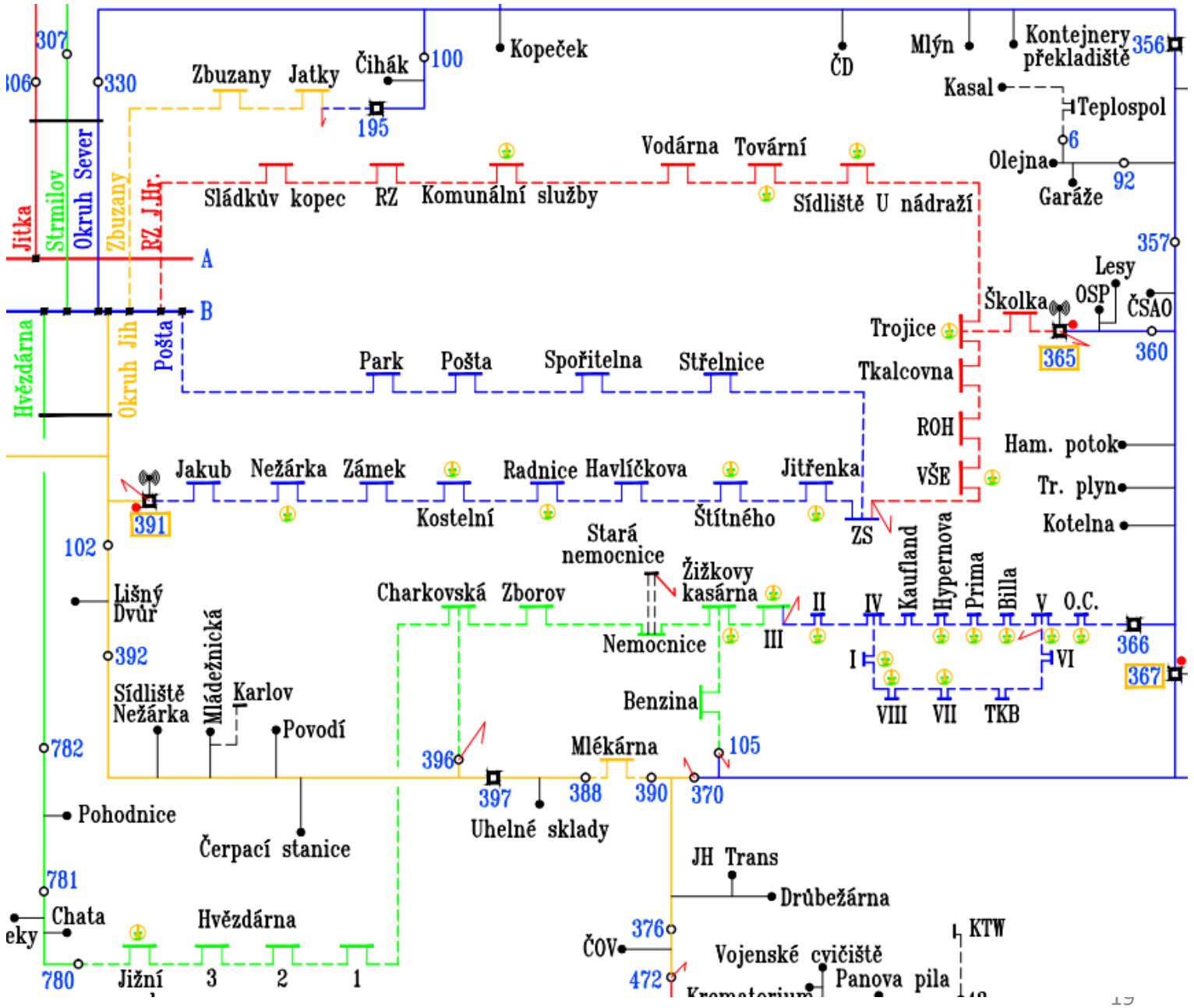


fig. 21: North-American overhead MV distribution layout (each phase shown).

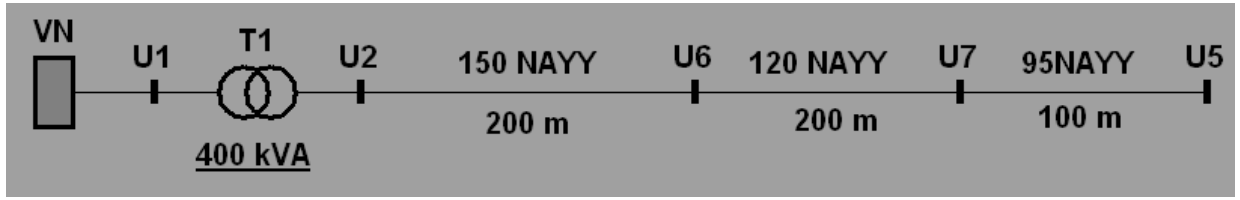
MV cable system

- open ring system

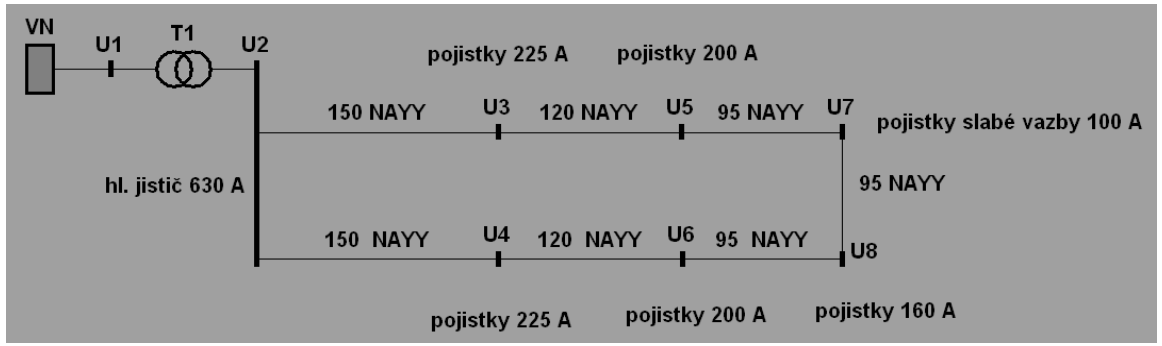


LV distribution system

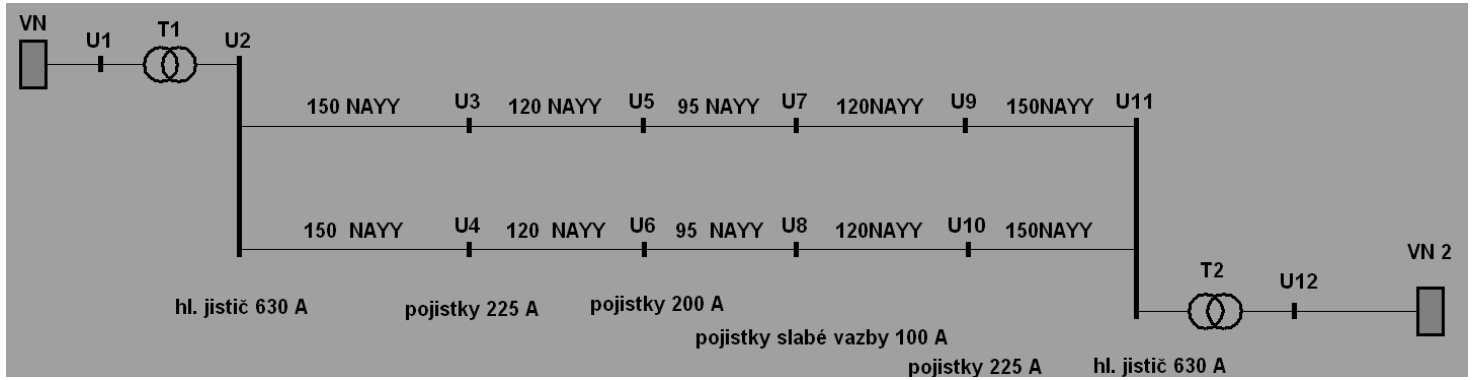
- Radial system



- Open ring systém



- Meshed system

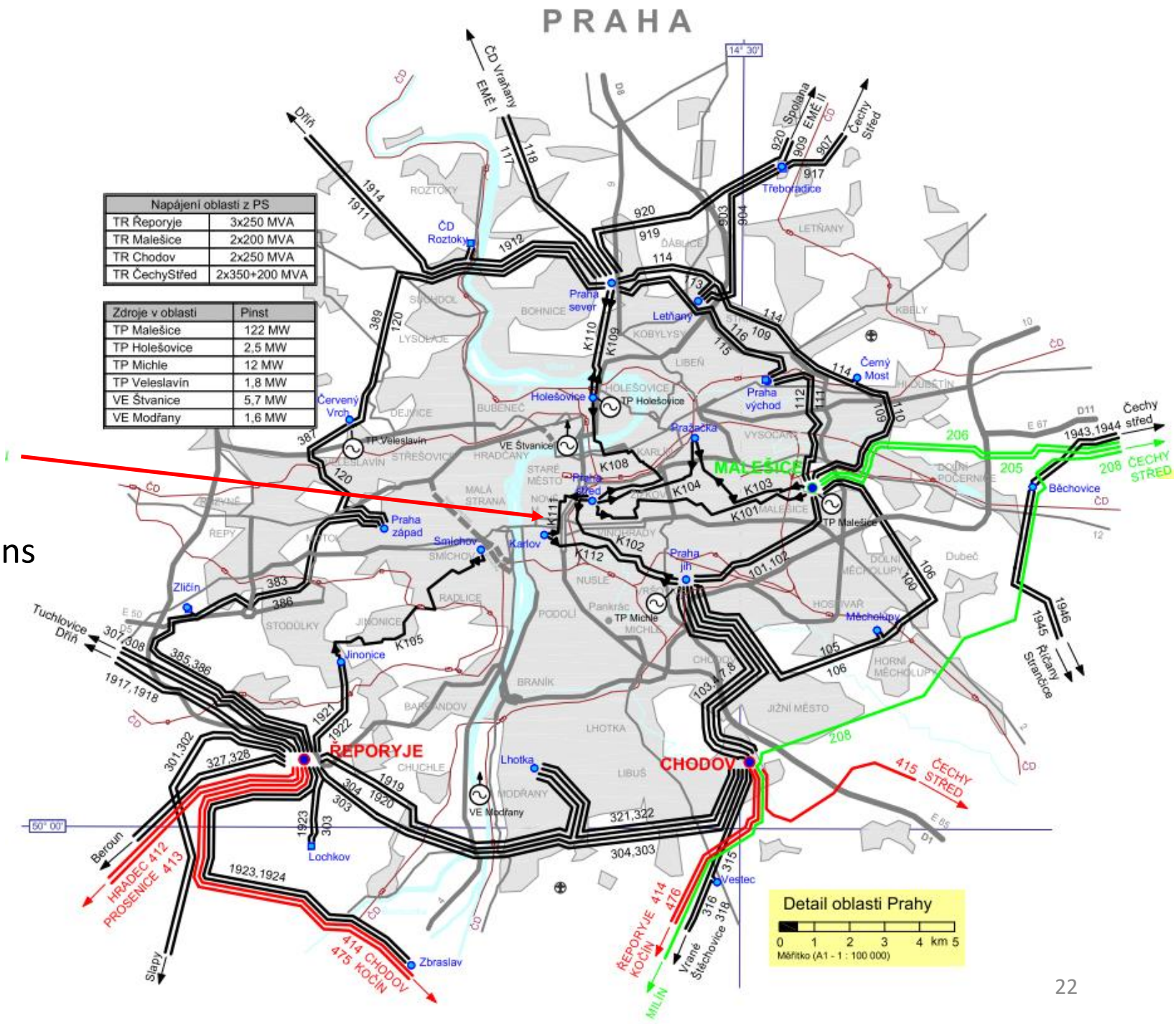


City supply systems

City supply system

- From 110 kV system
- Several supply points
- Toward city – 110 kV cables

- In centrum gas-insulated stations





GIS station

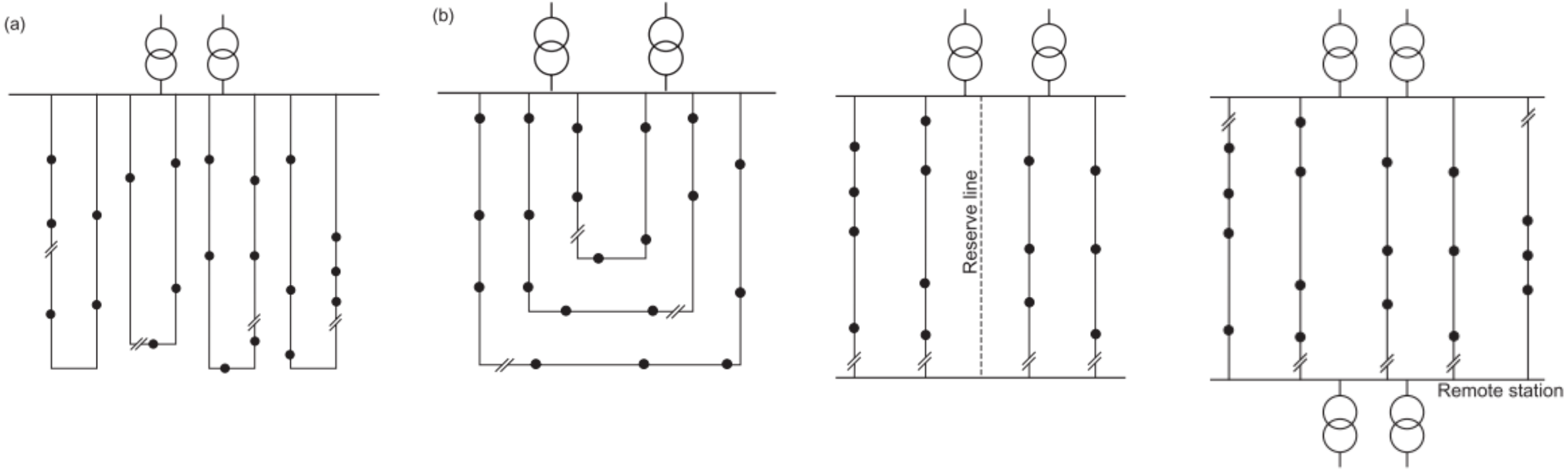


cable channel



MV cable system – single-level network

MV/LV stations are supplied directly by cables from HV/MV supply stations



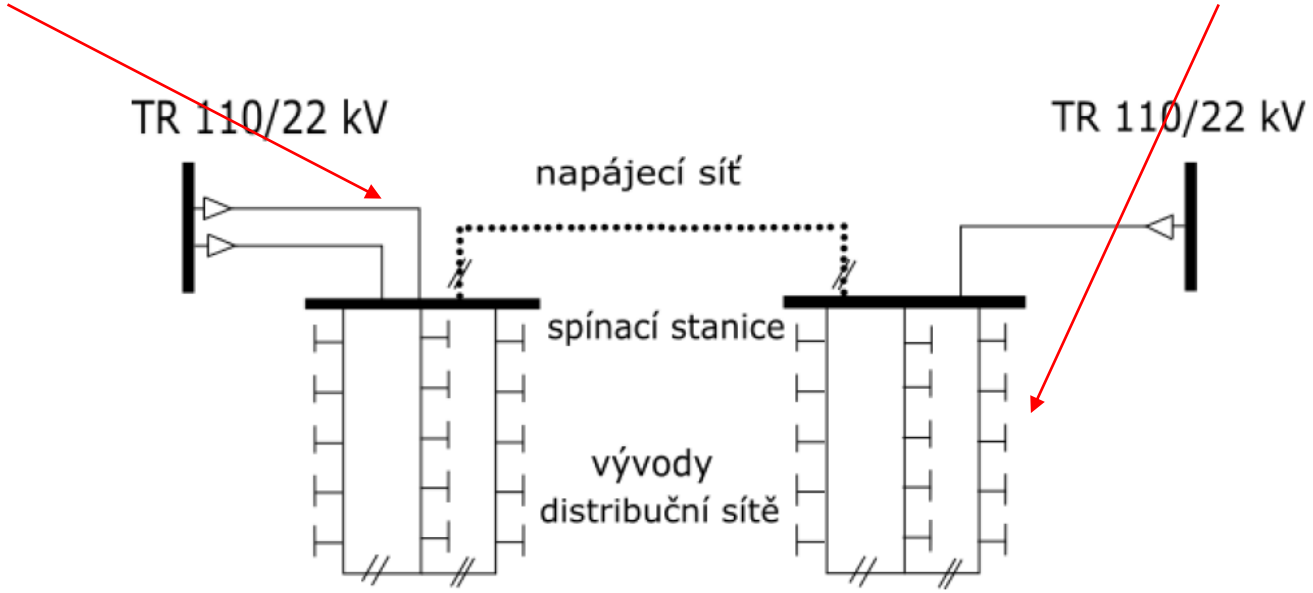
// Disconnection point (n.o.)

• MV/LV transformer connected through fuse or disconnecting switch

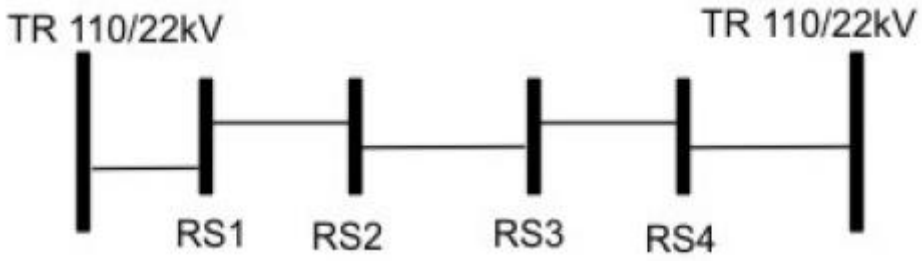
MV cable system – two-level network

Primary MV feeders sypply MV switching stations

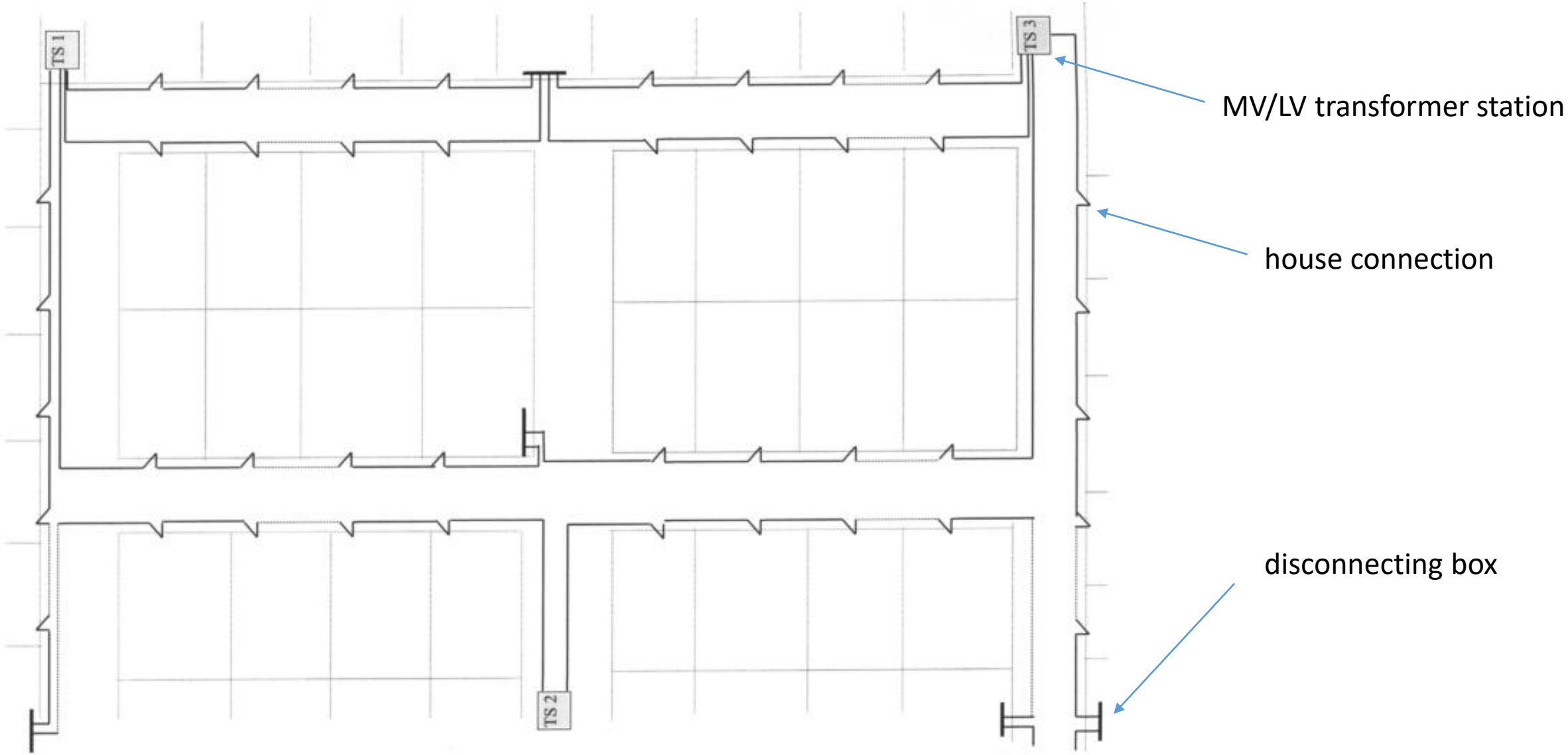
Secondary feeders sypply MV/LV stations



Line power supply of MV switching stations (RSx)



LV cable networks



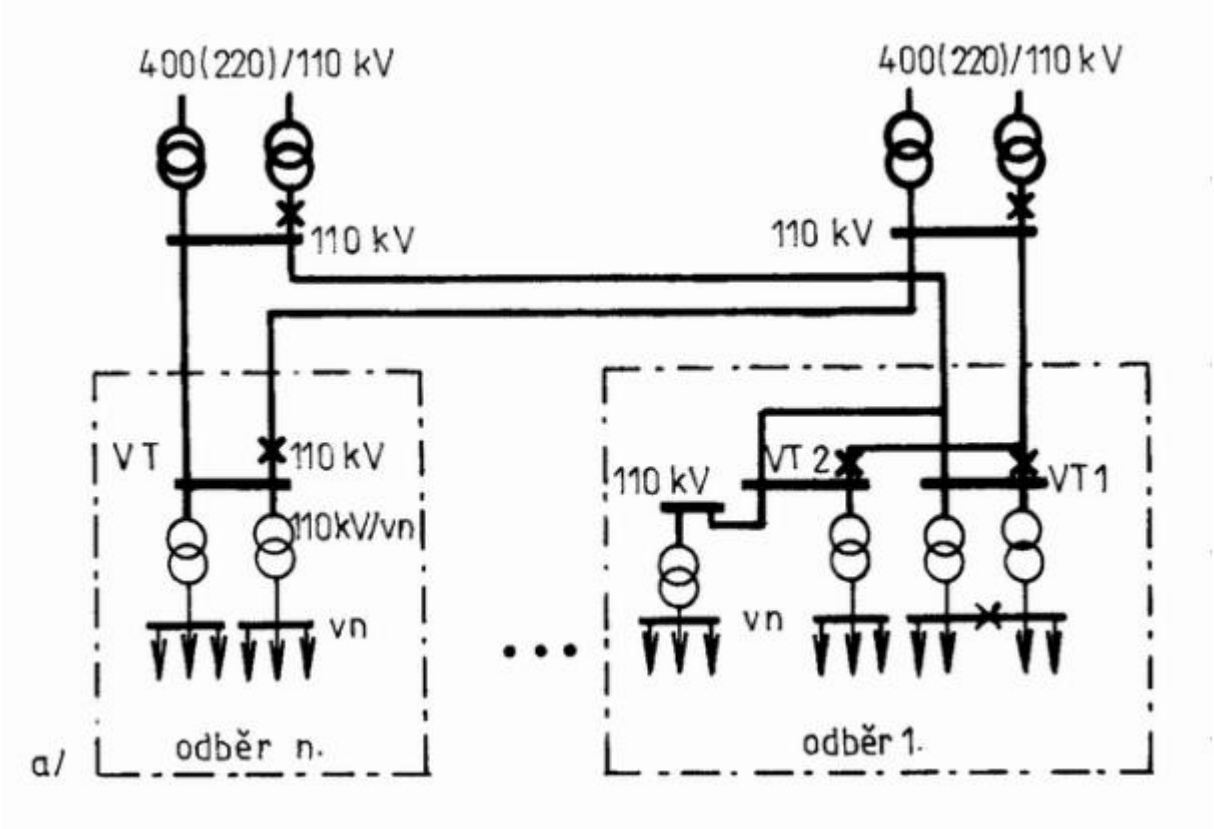
Industrial supply systems

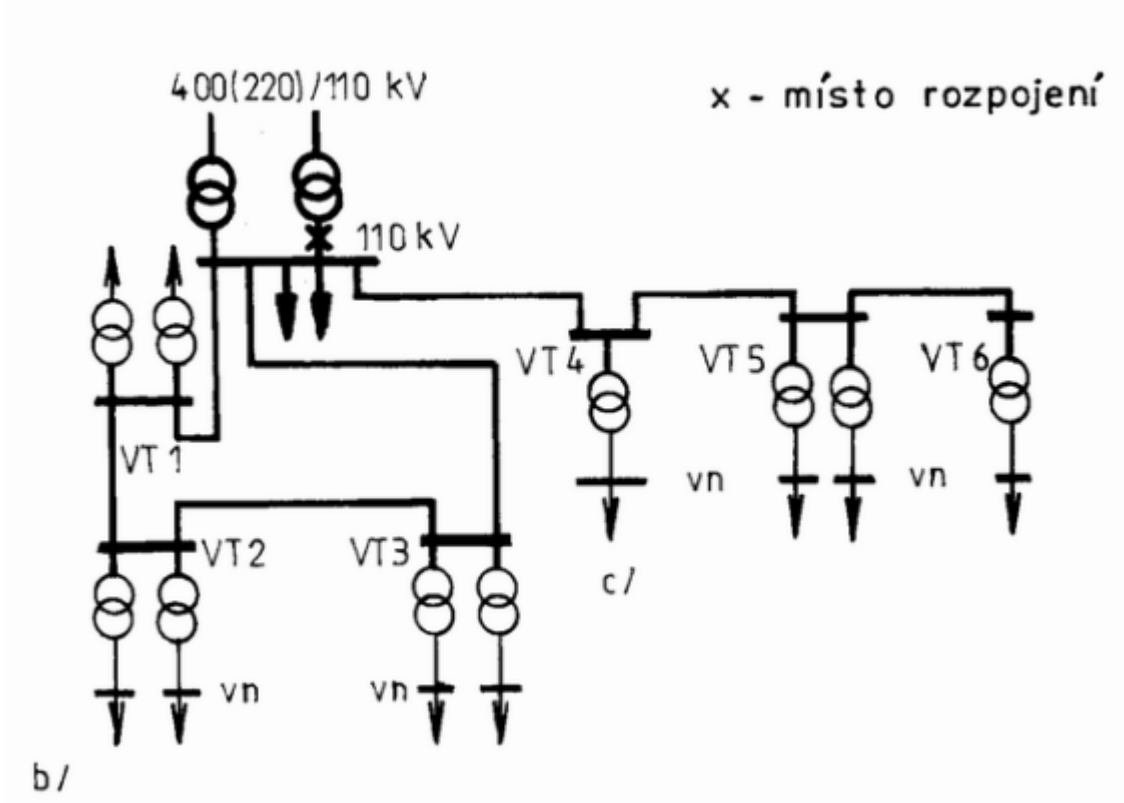
Industrial supply systems

Connection of a industrial plant into distribution system

- Into 110 kV system
  - Large industrial plants – over 10 MVA
  - One or several input station (VT, VR) – HV and MV
  - One or several main station (HR) – in center of demand
  - Distribution stations (PT, PR) close to consumption
- Into 22 kV system
  - Middle and small industrial plants – up to 10-15 MVA
  - Small industrial plants – input and main stations merged into one station

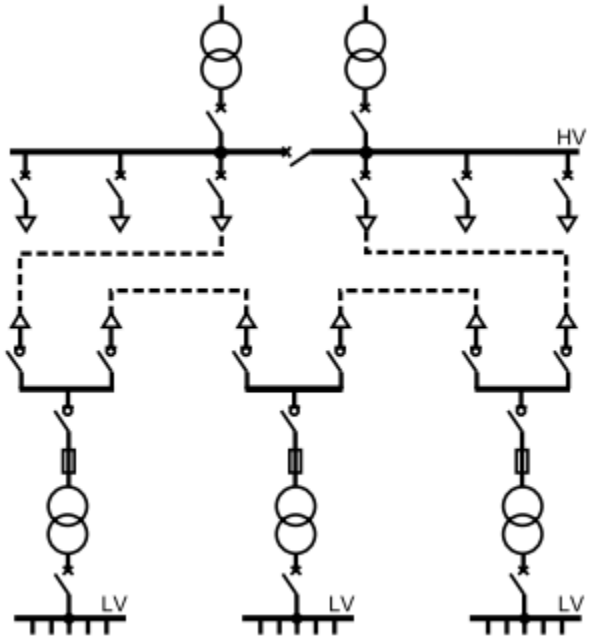
Connection of input station into HV system



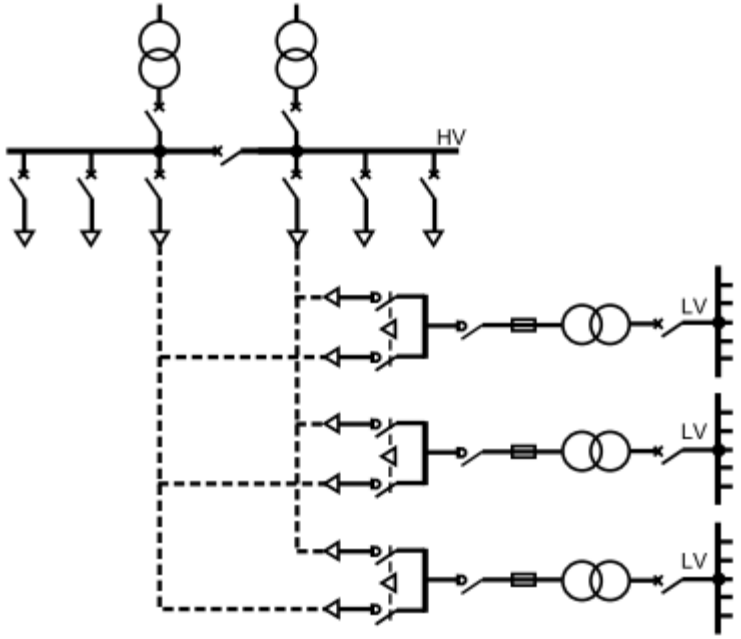


Basic concepts of MV sypply system

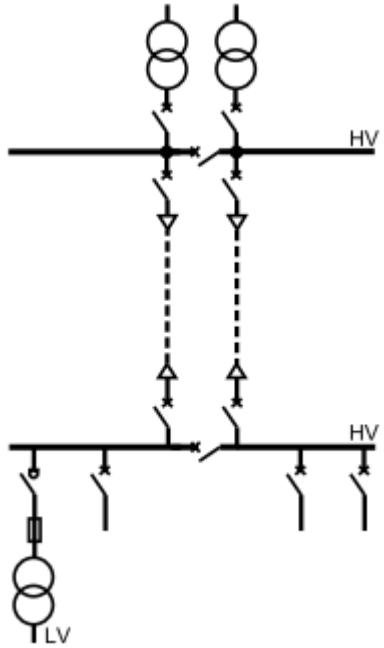
Ring



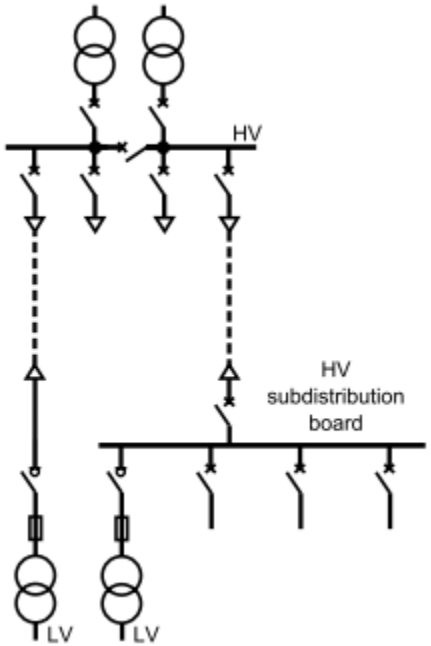
Double radial



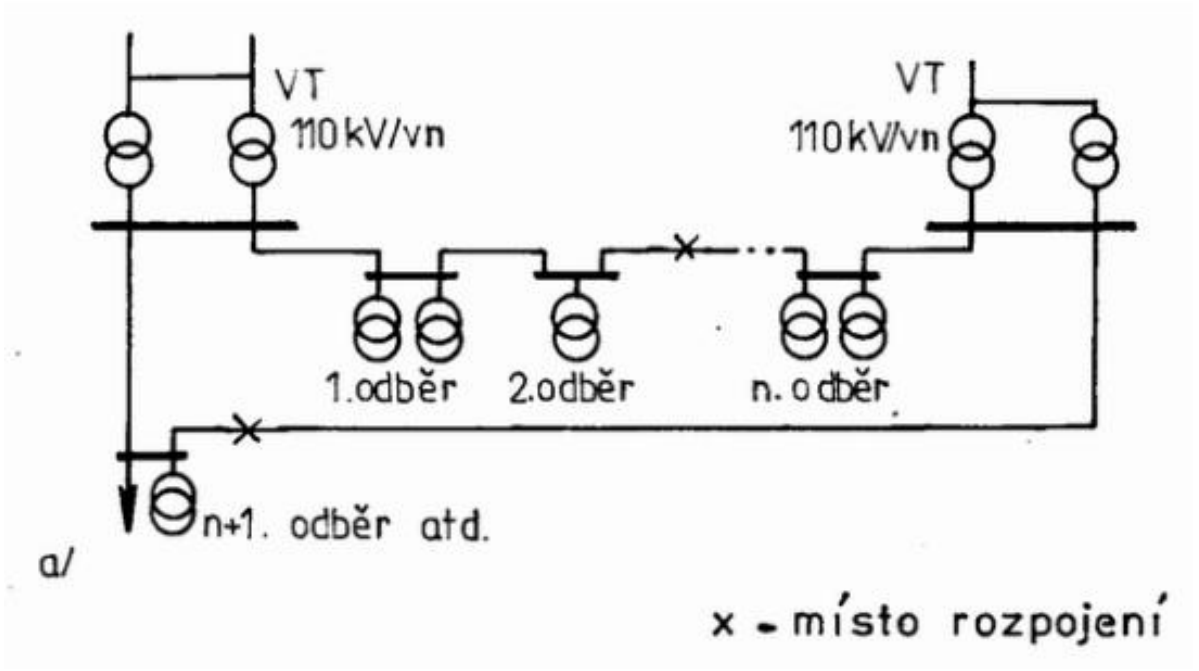
Double line

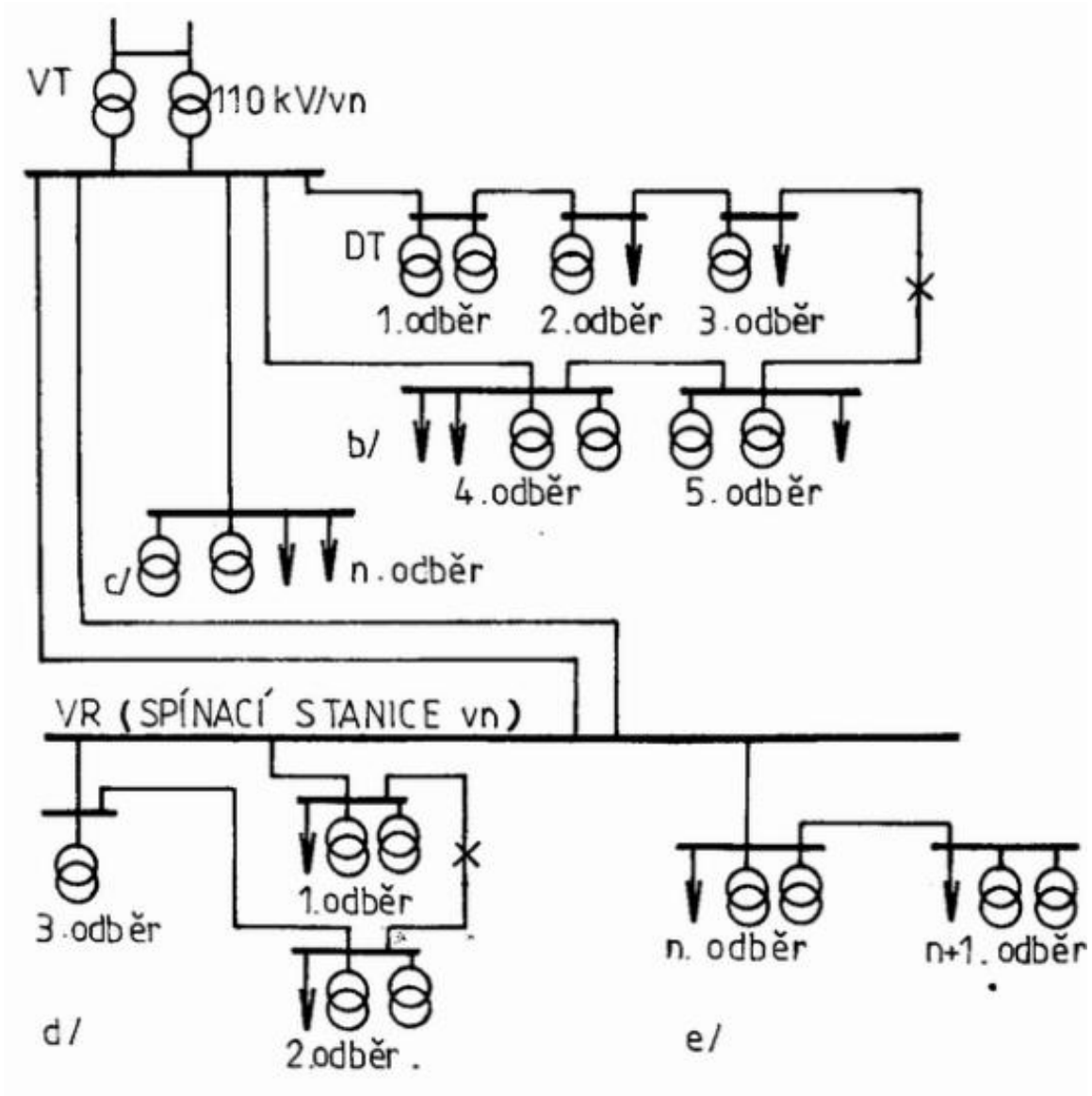


Radial

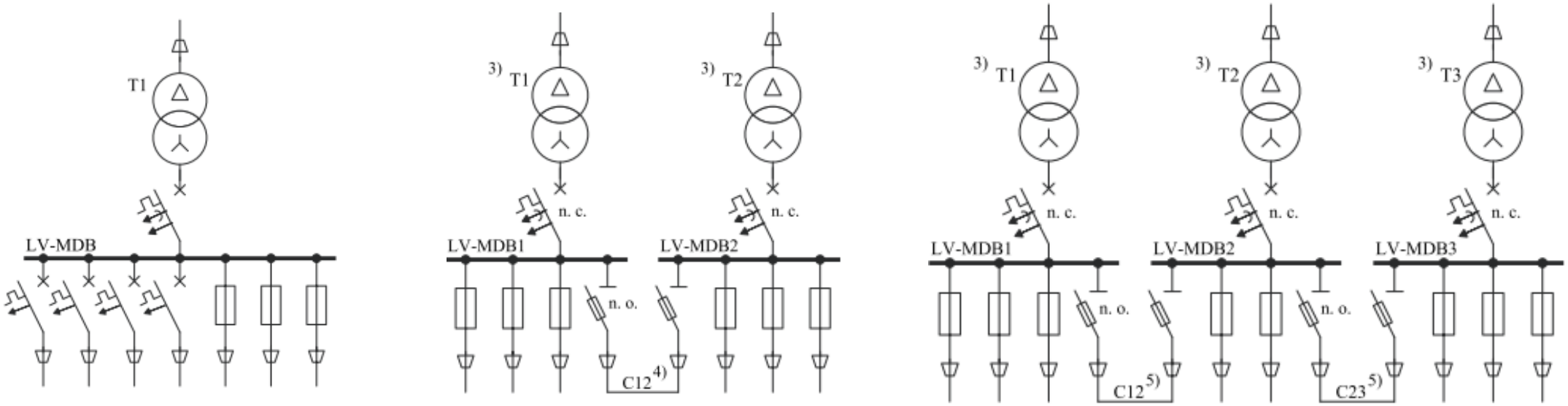


Basic concept of MV sypply stations



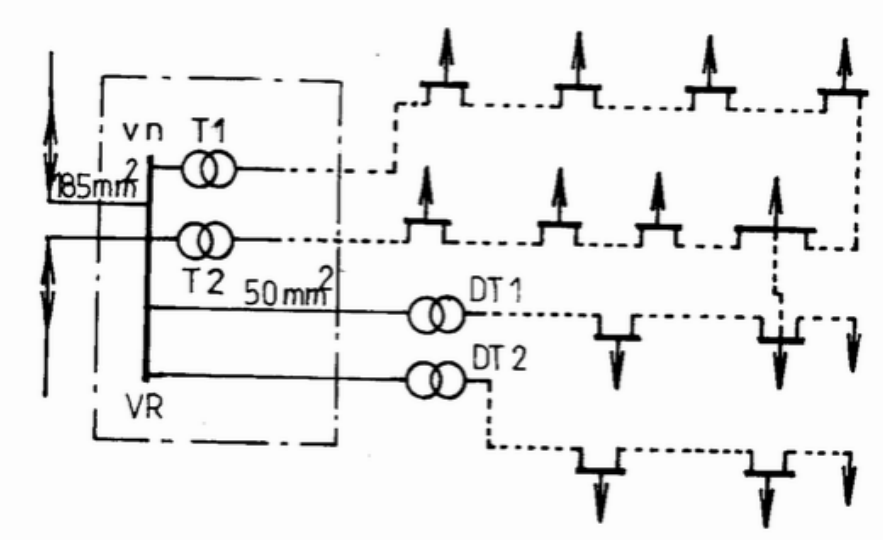


Concepts of MV/LV supply stations



LV networks

- radial
- double radial
- ring
- meshed →



Power supply concepts of a large industrial plant

