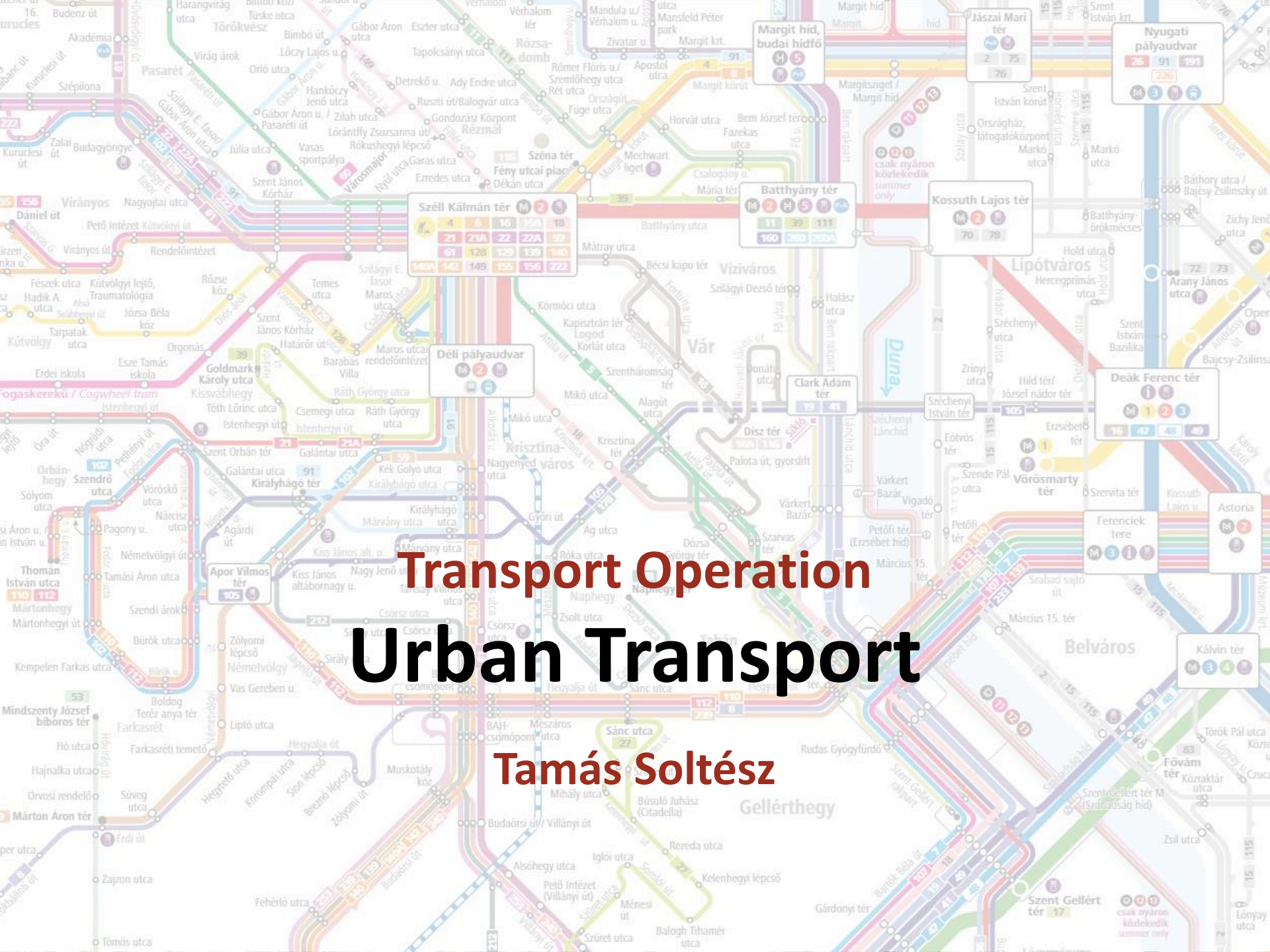


Transport Operation

Urban Transport

Tamás Soltész

Introduction

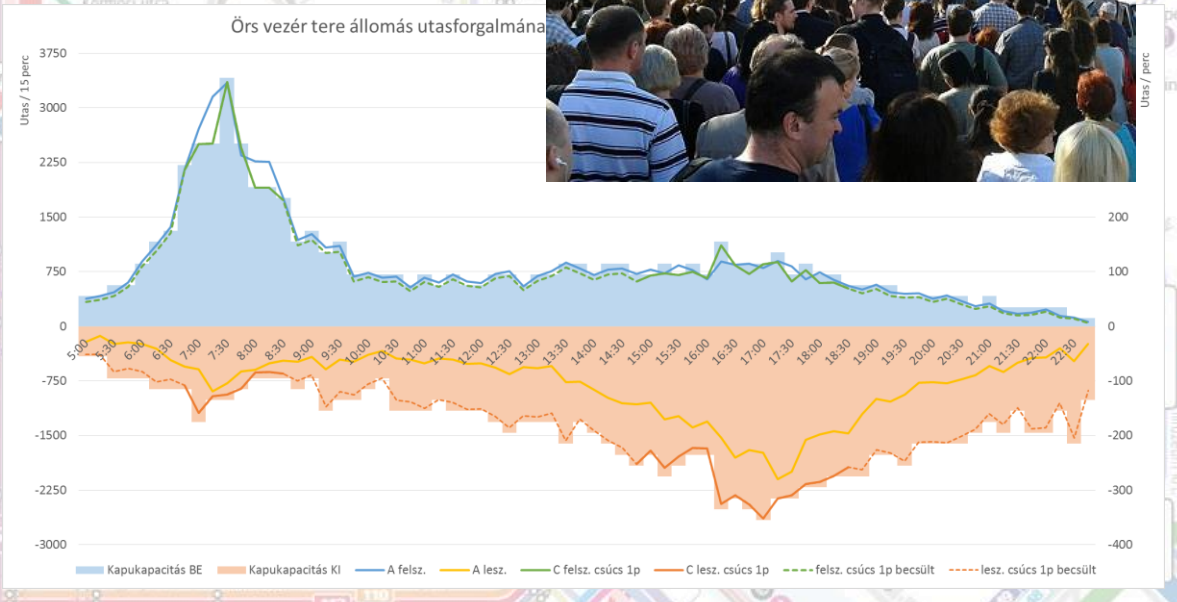
- Urban transport: the part of the transport system that is designed for serve transportation needs within a city
- Importance of urban transport:
  - Growing population of cities (more than half of world population)
  - The main part of travels takes place in cities
  - Capacities of road transport run out easily (especially at intersections) and are hard to increase (expenses, space)

Main features of transport systems (sorted by travel distance)

	Long distance transport	Regional (sub-urban) transport	Urban transport
Travel distance	Long	Up to ~100 kms	A few kms
Typical travel frequency	A few times in a month or rarer	Daily (or rarer)	Daily
Motivation	Business/leisure	Work/leisure	Work/school
Traffic volume	Relatively low	High	Very high
Modal split (share of public transport)	Usually low (except for air transport)	Medium (depends on region)	High (depends on city size & pop. density)
Typical PT headway (service frequency)	1 hour – 1 week	5-10 min – 2 hours	~1 min – 20-30 min

Specialities of urban transport

- Mainly work/school-based traffic
- Short travel distance, high traffic
- Crowded peak hours
- Traffic is often disturbed
- Limited space, high population density
- Environmental issues have to be concerned
- Modal split is a key question

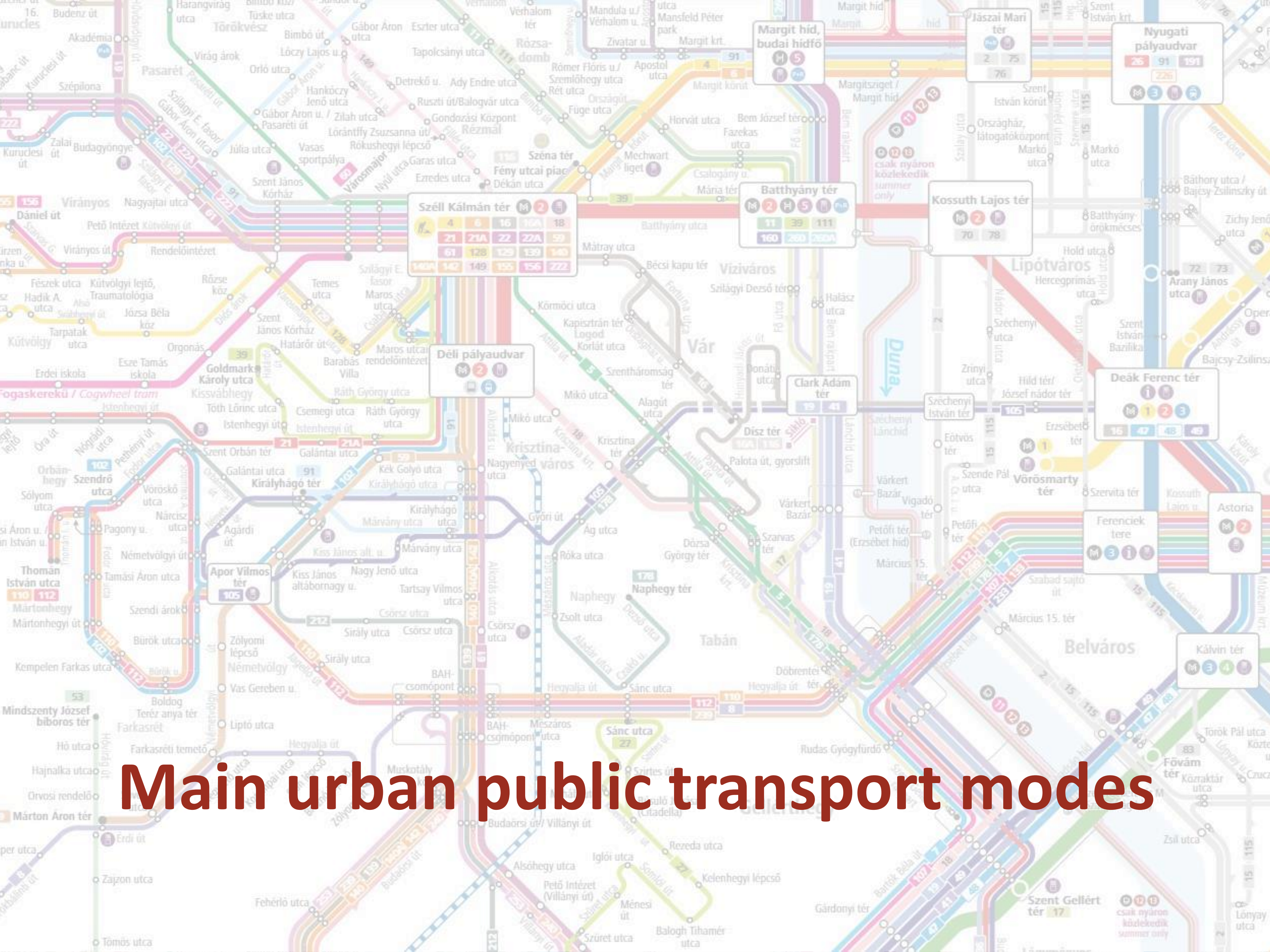


Urban road transport

- Dense network
  - Many intersections, frequent stops, lower speed
  - Importance of traffic management
- Very high traffic
  - Traffic jams
  - Capacity is limited mainly by intersections
- Environmental issues:
  - Road traffic is often restricted
- Hard to improve (limited space)

Urban public transport systems

- High service frequency (short headways)
  - Better organization
  - More developed passenger information systems (from route signs to real-time data)
- Very high traffic
  - Advanced infrastructure
  - Multi-level networks in large cities (trunk and feeder lines)
- Environmental issues, energy costs
  - Electric propulsion is common
- Special demands
  - Several types of public transport systems



Main urban public transport modes

Classification and evaluation of urban transport modes

- Technical aspects:
  - Track: fixed-rail system or not; contact (tyres or iron wheels)
  - Priorization (vehicles run together with road traffic or have separate lane/track; priority at crossings)
  - Vehicle: propulsion (diesel or electric), floor level
- Service parameters:
  - Passenger capacity (headway, vehicle size)
  - Coverage (stop distance)
- System function:
  - primary/trunk lines (long distance, high speed) or
  - local connections/feeder lines (short distance, lower speed)

Urban buses – technical features

- Differences to long distance buses: vehicles
  - Number of doors
  - Number of seats – standing places
  - Level of entry

Service parameters of bus lines

- Stop distance: 300 – 500 m
- Vehicle capacity: 30 – 110 passengers
- Headway (time interval between vehicles): from ~1 min to 30 min
- Advantages: flexibility, little infrastructure needs
- Disadvantages: little vehicles, expensive fuel
- Main application:
  - connecting residential areas with transport hubs or the city centre (low or medium traffic feeder lines)

Trolleybuses – technical features

- Vehicles: similar to urban buses, but with electric propulsion
- Trolleybuses gain energy from overhead wires (direct current); but new vehicles usually have batteries or auxiliary engines

Service parameters of trolleybus lines

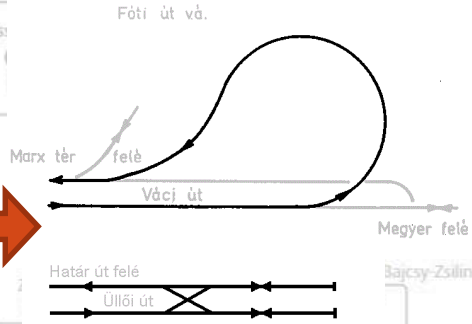
- Stop distance: 300 – 500 m
- Vehicle capacity: 60 – 110 passengers
- Headway: from ~1 min to 15 min
- Advantages: can evade obstacles, low energy costs
- Disadvantages: little vehicles, medium infrastructure needs
- Main application: similar to buses, but only:
  - On busy lines
  - In environmentally sensitive areas
  - On hilly terrains

Trams

- The main technical difference to trains:
  - Trams have to be able to go through on steep curves (related to streets)
  - Trams must not have long braking distances (they run together with road traffic)

Trams – technical features

- Vehicle types:
  - Multiple-car sets or articulated trams
  - One or two direction (related infrastructure)
  - Doors on only one or both sides



- Supply of energy: from one overhead wire (current is closed through the rails); direct current
- Track types:
  - Covered (with pavement or either grass)
  - Uncovered (like railways)

Service parameters of tram lines

- Stop distance: 300 – 500 m
- Vehicle capacity: 80 – 350 passengers
- Headway: from 1,5 min to 15 min
- Advantages: large vehicles, low energy costs
- Disadvantages: high infrastructure costs, not flexible
- Main application: at medium/high traffic:
  - Connecting dense residential areas with the city centre
  - High capacity transversal connections
  - Serving short-distance transportation needs in city centres

Suburban railways

- Special kind of railways: very high frequency
  - Dedicated lines / tracks; separated from road traffic
  - Same or similar train types on a line (normally no fast or freight trains)
- Interoperability is possible with national railways, tram networks or metro lines

Suburban railways – technical features

- Vehicles:
  - only electric multiple units (without locomotives)
  - high capacity (standing places)

- Various technical solutions:
  - Energy supply: overhead wire or third rail; direct or alternating current
  - Low, medium or high platforms
  - Medium or high-floor vehicles

Service parameters of suburban railways

- Stop distance: 800 – 2000 m
- Train capacity: 200 – 1000 passengers
- Headway: from 2 min to 60 min
- Advantages: very large vehicles, high speed, reliability
- Disadvantages: high infrastructure costs, dedicated lines are needed
- Main application: at long-distance and high traffic volumes:
  - Connecting the outskirts' main points, suburbs and nearby towns with the city

Metro (rapid transit)

- Metro has the highest capacity of transport modes
  - Completely separated from any other traffic
  - High frequency, large capacity trains
- Most of metro lines run underground, but they can have also surface-level or elevated sections

Metro – technical features

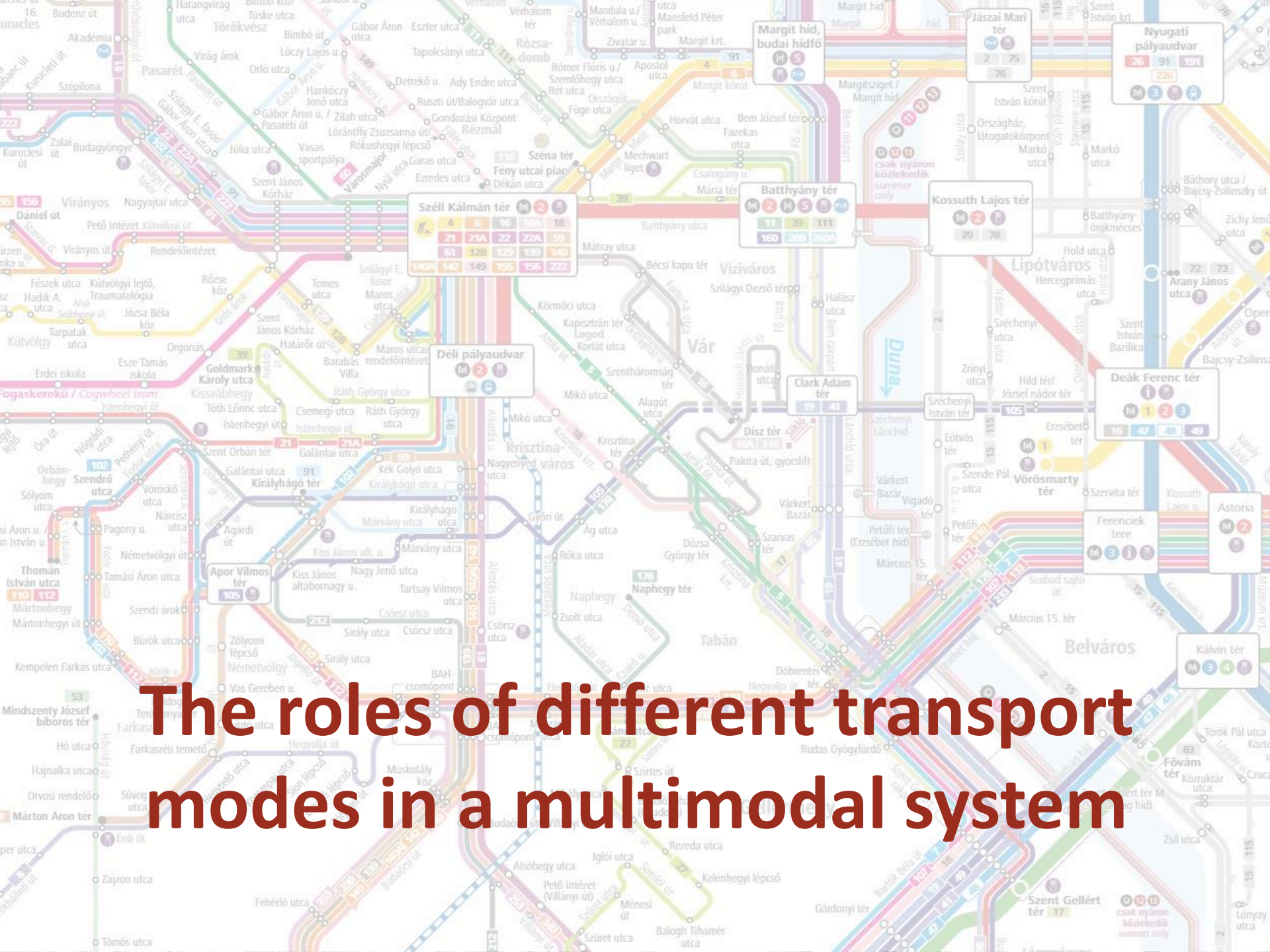
- Vehicles:
  - Large capacity, several doors
  - Good acceleration
- High platforms (entry on the same level)
- Energy supply:
  usually by third rail;
  direct current

Metro – technical features

- High level of automation
- Underground sections:
  - Sub-surface lines (cut and cover technique)
  - Deep-level lines (bored tunnels)

Service parameters of metro lines

- Stop distance: 600 – 2000 m
- Train capacity: 400 – 1500 passengers
- Headway: from 1 min to 15 min
- Advantages: very high capacity, high speed, independency from traffic and weather
- Disadvantages: very expensive infrastructure (tunnels, stations etc.) is needed
- Main application: at the highest traffic volumes:
  - On the primary lines (e.g. from main hubs to city centre);
  - Metro is the ‘backbone’ of public transport system



The roles of different transport modes in a multimodal system

Capacity of urban transport lines

- A line's passenger capacity depends on its frequency and vehicle capacity:

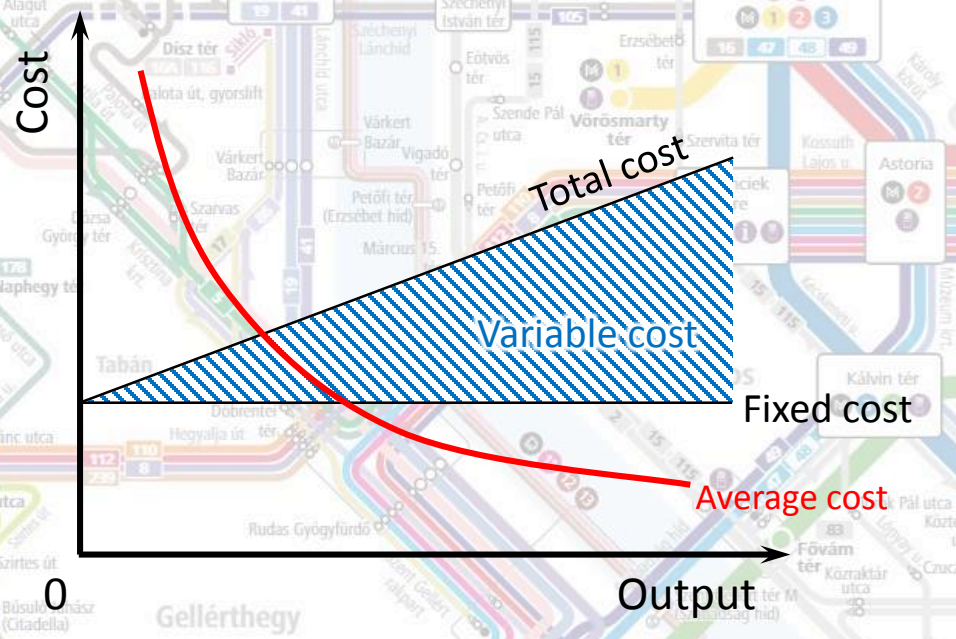
$$C = V \cdot n = V \cdot \frac{60}{t_h} \left[\frac{places}{hour \cdot direction} \right]$$

V: Capacity of vehicle (set)
n: Number of runs per hour
t_h: Headway [min]

- In scheduling, we plan with 80% usage of capacity at the busiest section

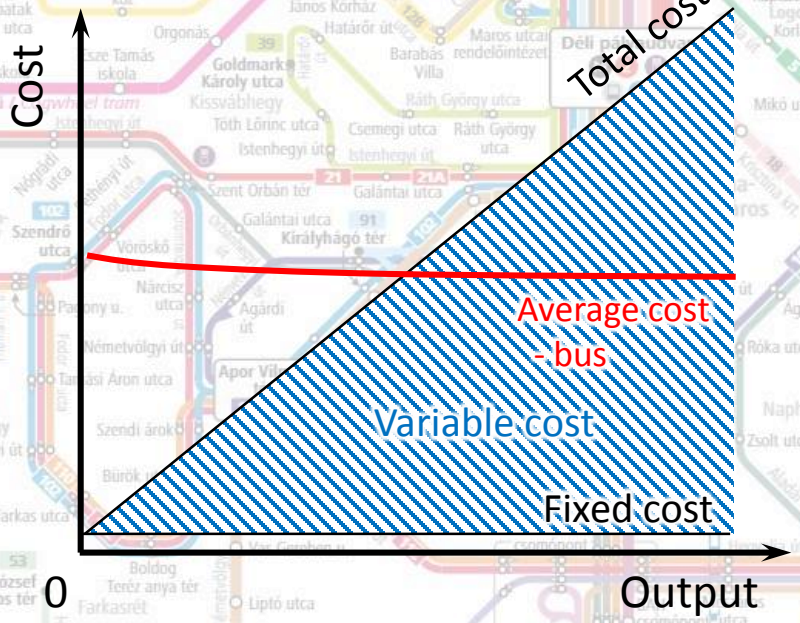
Costs of urban transport

- Fixed cost:
  - Infrastructure (lines, stations/stops)
  - Vehicles, depots
  - Traffic control and information systems
- Variable cost:
  - Wages of personnel
  - Energy consumption
  - Vehicle maintenance
- Average cost: Total cost/Output



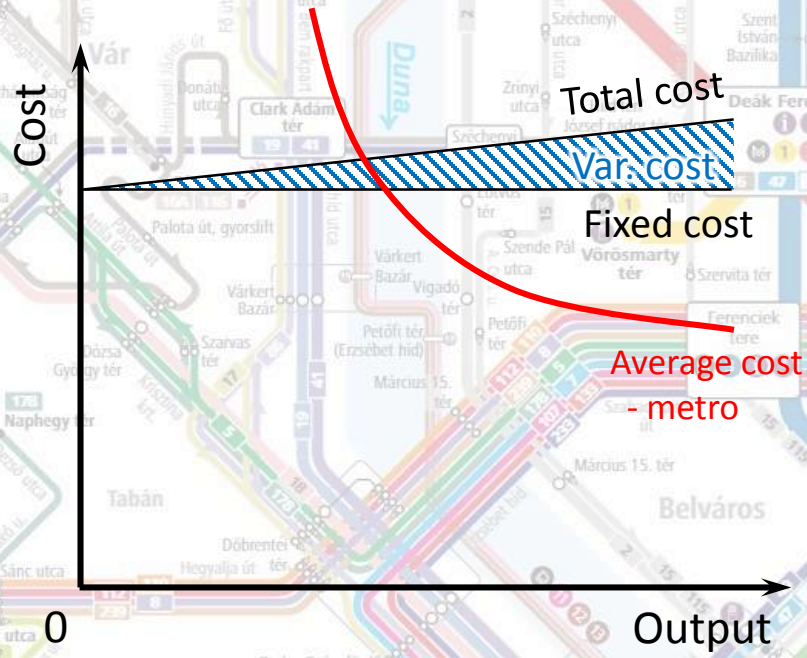
Costs of urban transport - examples

- Bus



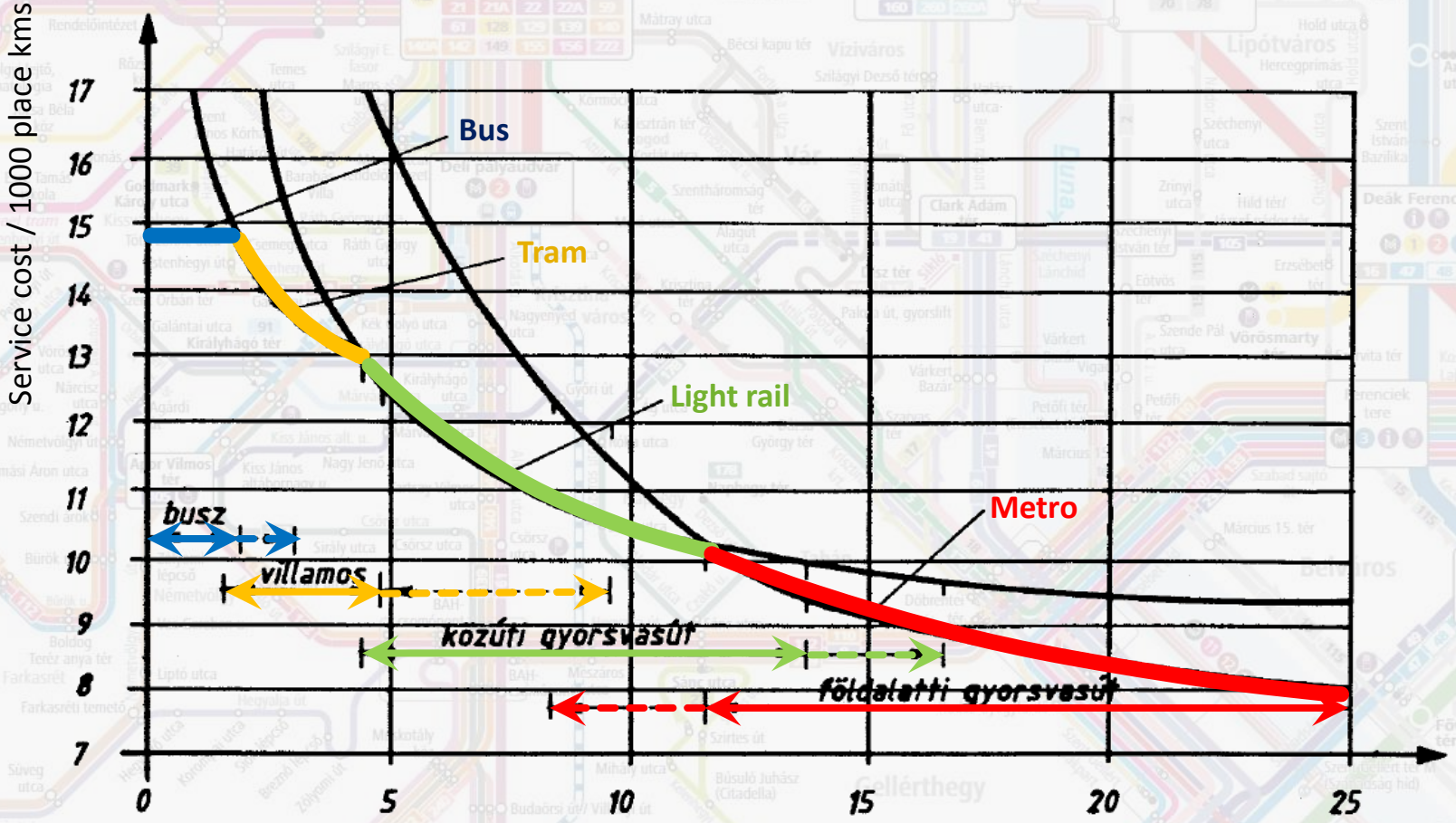
- Low fixed costs
- High variable costs
- Nearly constant avg. cost

Metro



- High fixed costs
- Low variable costs
- Steeply falling avg. cost

Application ranges of urban transport modes based on average service costs



Comparison of public transport modes

Mode	Separation from road traffic	Stop distance	Average travel speed	Application range (pass. capacity)
Bus	On specific segments	300 – 500 m	15-20 km/h	0 – 5000 places/h/dir
Trolleybus	On specific segments	300 – 500 m	15-20 km/h	1500 – 5000 places/h/dir
Tram	Most of the network	300 – 500 m	15-20 km/h	2000 – 15000 places/h/dir
Suburban railway	On the whole network	800 – 2000 m	30-40 km/h	10000 – 20000 places/h/dir
Metro	Completely (no crossings)	600 – 2000 m	25-35 km/h	12000 – 40000 places/h/dir

Aspects of choosing the mode of a public transport line

- Traffic volume:
  - covering the needed passenger capacity
  - minimizing operation costs
- Network role:
  - local, feeder lines → short stop distances
  - primary line → high travel speed
- Serving important direct connections
- Existing infrastructure
- Feasibility, costs

The planning of integrated public transport systems

- Concept of integrated transport:
  - Vertical cooperation – performance (choosing the right mode)
  - Integrated control (not by modes / operators)
  - Integrated price system (for all transport modes)

Tim Baric felvétele

Thank you for your attention!