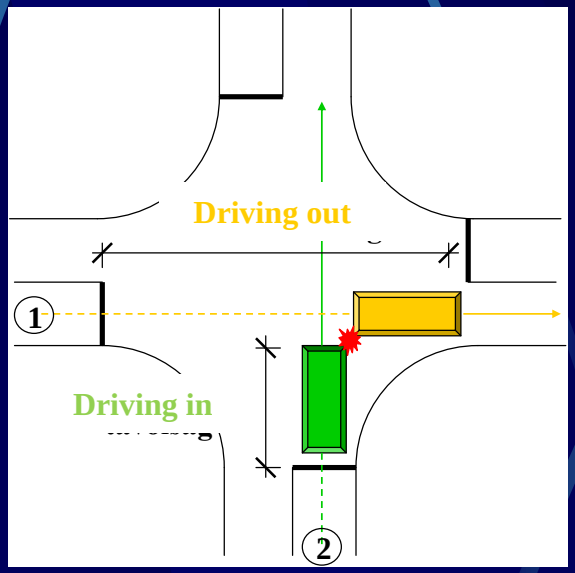
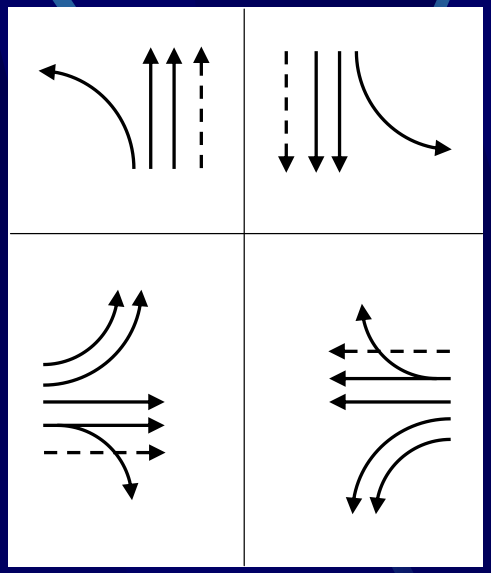
Signalised intersections





Urban Transport 11.
András Gulyás PhD habil
associate professor

Content

- Principles of signalised traffic control
- Definitions in signalised traffic control
- Implementation of signalised junctions
- Traffic planning of signalised junctions
- Co-ordinated signalised traffic control
- Examples of signalised junctions
- Adaptive traffic control systems

Definitions in signalised traffic control

Intersections under traffic signal control operate on the basis that separate time periods are allotted to conflicting traffic movements so that each can make safe and efficient use of the carriageway space available.

Traffic signals are usually installed only at at-grade intersections in built-up areas.

The main goal is to reduce time losses in the junction.

A detailed geometric design of elements is required.

Definitions in signalised traffic control

Phase: Group of movements permitted at the same time (green signals at the same time). In a four-leg intersection there are 12 possible movements to be grouped into phases.

Time period (P): Time between repeated signal patterns. Usual time periods applied: 60...90...120 s.

Phase timing plan: Splitting period into green times and intermediate times. Each signal group giving the same colour at the same time has its own row in the phase timing plan. There are also rows for pedestrian and bicycle movements.

Definitions in signalised traffic control

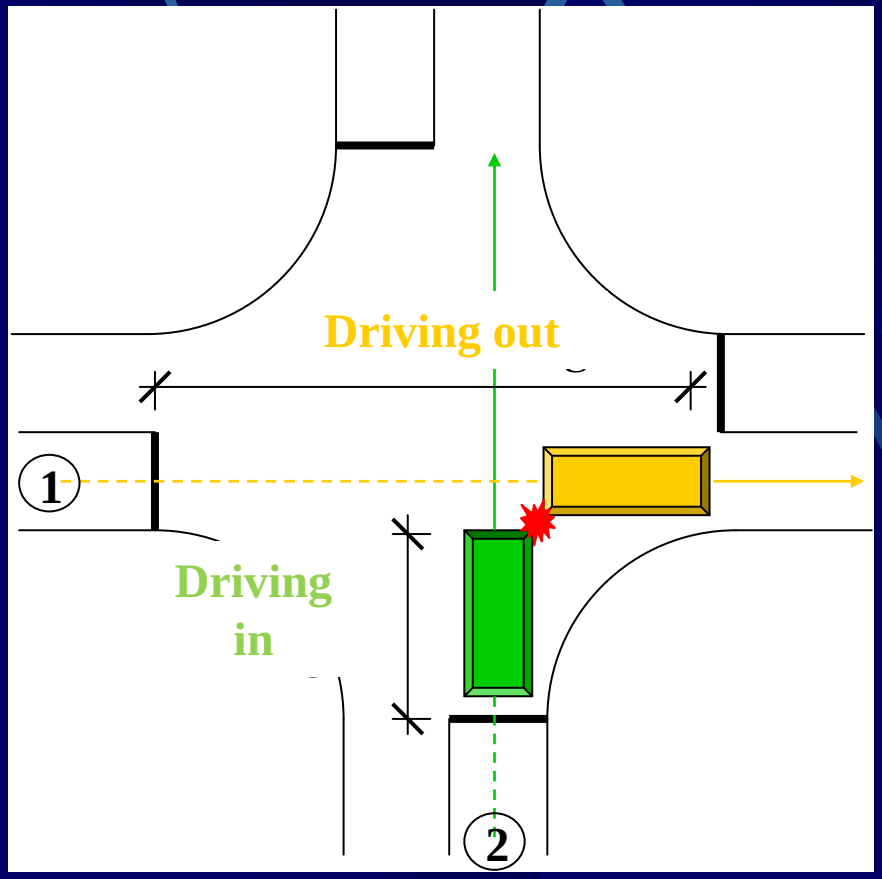
Intermediate time (t_{im}): in case of crossing or weaving movements this is the time between the end of the green time of the driving out and the start of the green time of the driving in rounded to secs for safety reasons.

Driving out time (t_{out}): time for driving from the stop line to the far end of the collision zone plus one vehicle length (6 m).

Driving in time (t_{in}): time for driving from the stop line to the near end of the collision zone.

Definitions in signalised traffic control

Intermediate time



Definitions in signalised traffic control

Fix program control: different programs (phase timing plans) for various parts of the day – morning peak, afternoon peak, daytime normal. Programs are changed by a clock at previously given points. This type of control is out-of-date.

Traffic dependent control: there are 2 traffic volume sensors in the approaching lanes – one is near the stop line (4 – 5 m) the other is at further distance (40 -60 m). The order of phases is given. It is possible to lengthen or shorten green times, even leaving out a phase.

Adaptive traffic control: every junction controller in every period gets its own phase timing plan according to area-widely mesured traffic volume data.

Definitions in signalised traffic control

Unopposed streams: phases without conflicts. The intersecting movements have got no same time green (excepting right turning vehicles and crossing pedestrians). An arrow in the signal head is possible only in this case. Recommended in higher turning traffic volumes.

Partially opposed streams: phases with conflicts (full green). Movements from opposite direction (straight and turning) may have green signal at the same time (and parallel pedestrians as well). Basic traffic rules are valid. No arrows in the signal head. Recommended when left turning traffic is smaller.

Definitions in signalised traffic control

Intermediate times for vehicle and pedestrian movements: must be calculated for every pair of possible conflicts (matrix of intermediate times).

Important for traffic safety.

Intermediate time =

= yellow time + driving out time – driving in time

Driving in speed is larger than driving out speed.

Implementation of signalised junctions

Traffic signal heads must be placed to be well visible and their signals must be unambiguous.

Recommended distance from the stop line in case of hanged heads (at 4,7 m height) is 7,5 – 16 m but in some cases this is not fulfilled.

It is favourable to apply a supplementary sign showing the remaining seconds of the phase (both for red and green).

Traffic planning of signalised junctions

Planning conditions are: volume and classification of traffic, its changes in time, the safety situation (accidents), local circumstances.

Time period and phase order can be determined based on the minimum time loss (optimal time period) or co-ordination conditions.

Time period is the sum of green and intermediate times. Minimum green times must be considered.

The maximum time period is 120 s for 4 phases.

Traffic planning of signalised junctions

Capacity (C, calculated for each phase and together):

$$C = (G / 2{,}0) * (3600 / P) \quad [pcu/h]$$

$$\text{Saturation rate} = \frac{\text{peak hour traffic}}{\text{capacity}}$$

Approximate length of vehicle sorting section:

$$L_o = 0{,}09 * V + 30 \quad [m]$$

Approximate length of vehicle waiting section:

$$L_f = 6 * (P - G) / 2 \quad [m]$$

Traffic planning of signalised junctions

Steps of design:

- **draft geometric design,**
- **determine phases for movements and order of phases,**
- **calculation of peak hour traffic and saturation factor for each phase**
- **detailed geometric design, signal head placing,**
- **calculation of intermediate times,**

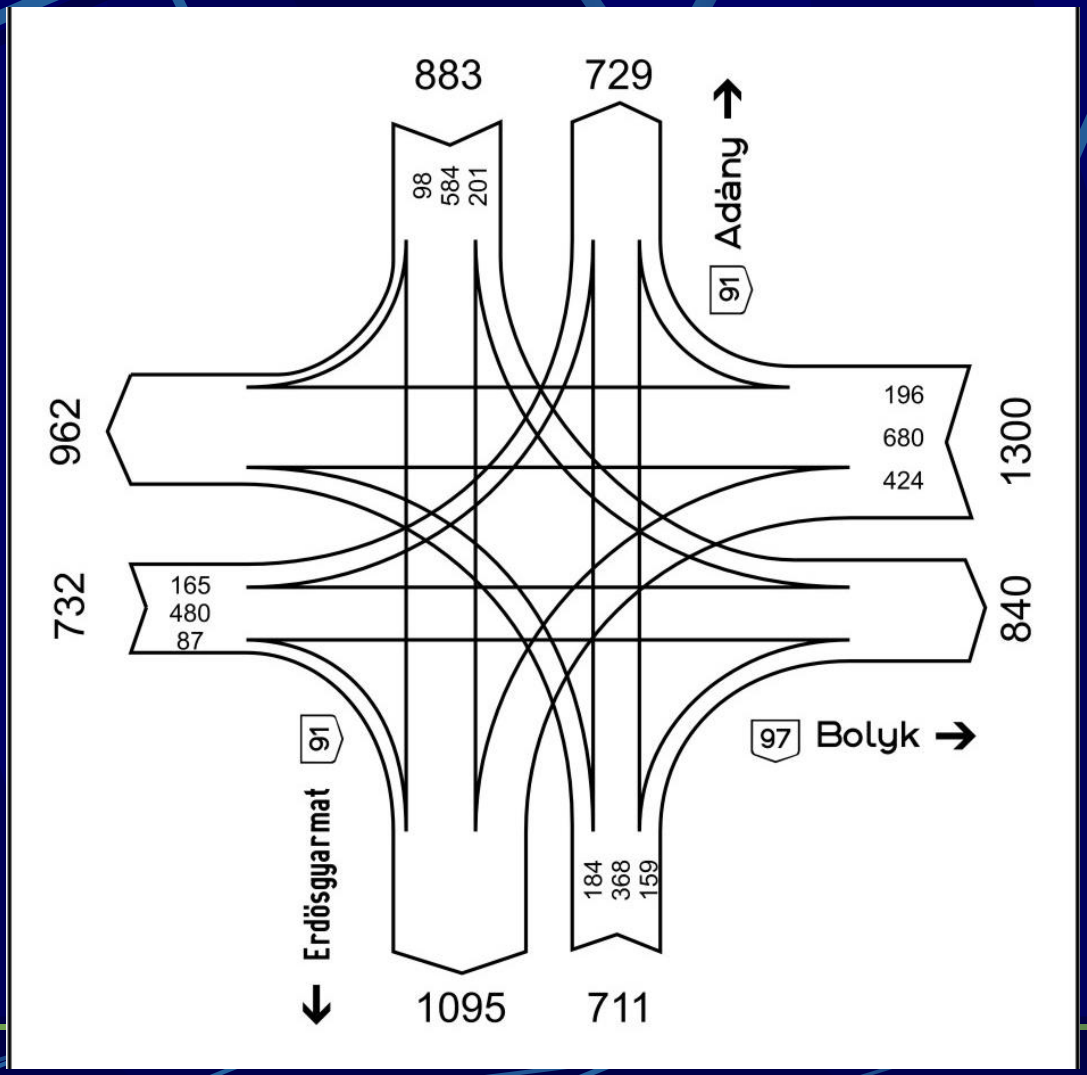
Traffic planning of signalised junctions

Steps of design (continued):

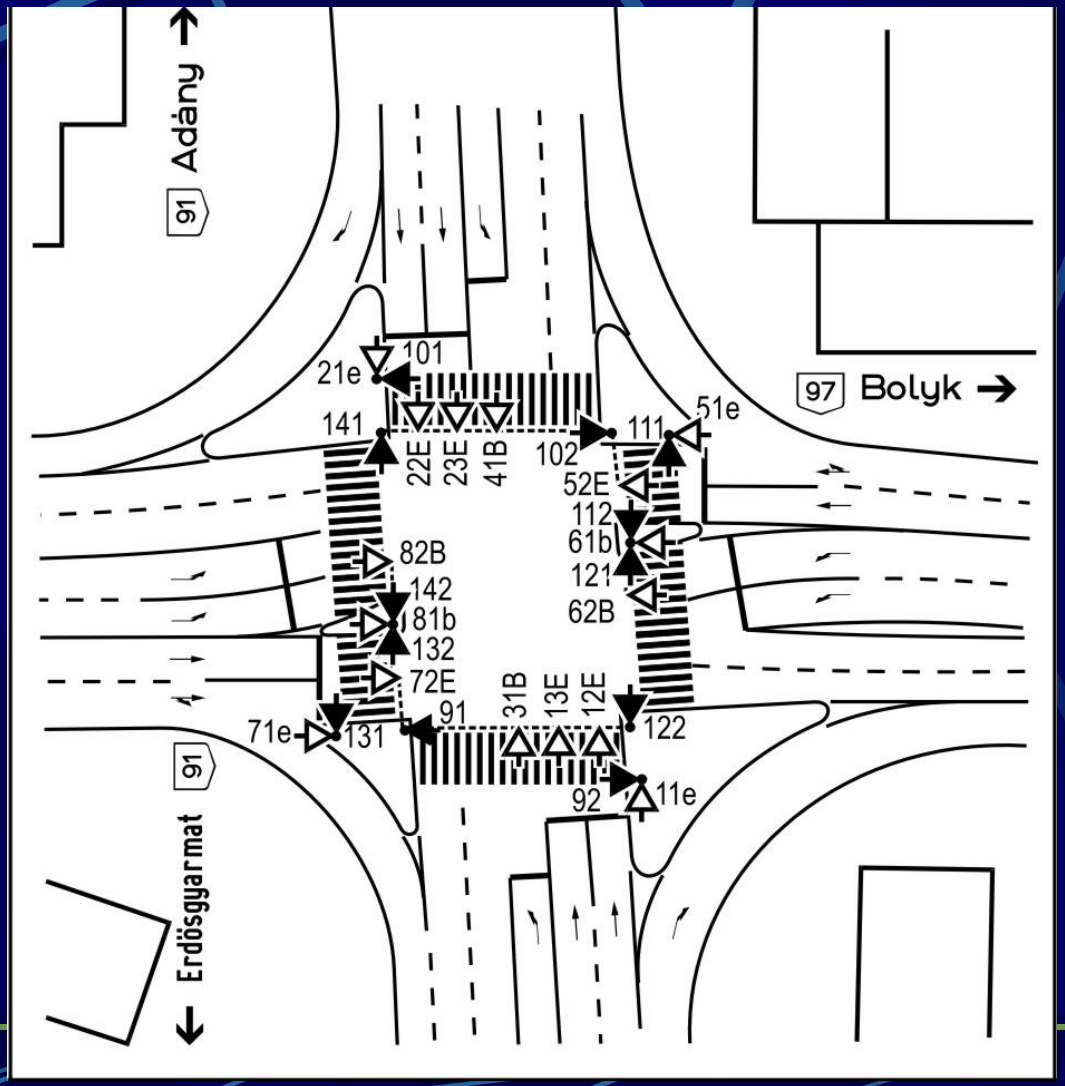
- establishing time period,
- calculation of green times,
- detailed capacity calculation,
- design of phase timing plan,
- calculation of waiting section length,
- refinement of geometric design,
- signal co-ordination design (if necessary).

Traffic planning of signalised junctions

Traffic movements



Traffic planning of signalised junctions

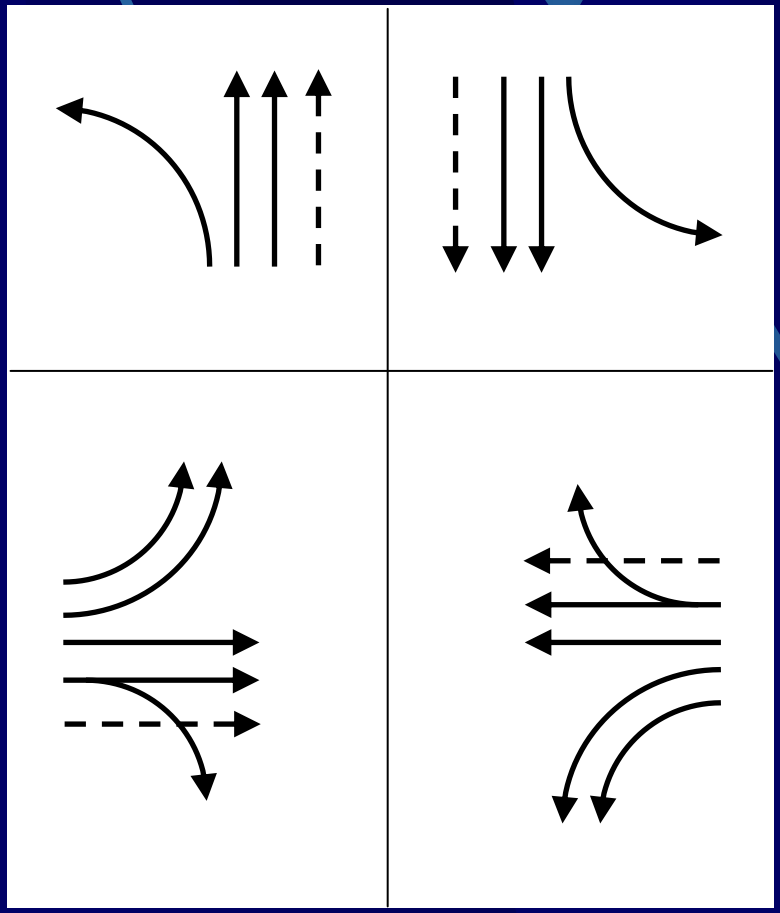


Geometric design

Traffic planning of signalised junctions

Phase 1.

Phase 3.



Phase 2.

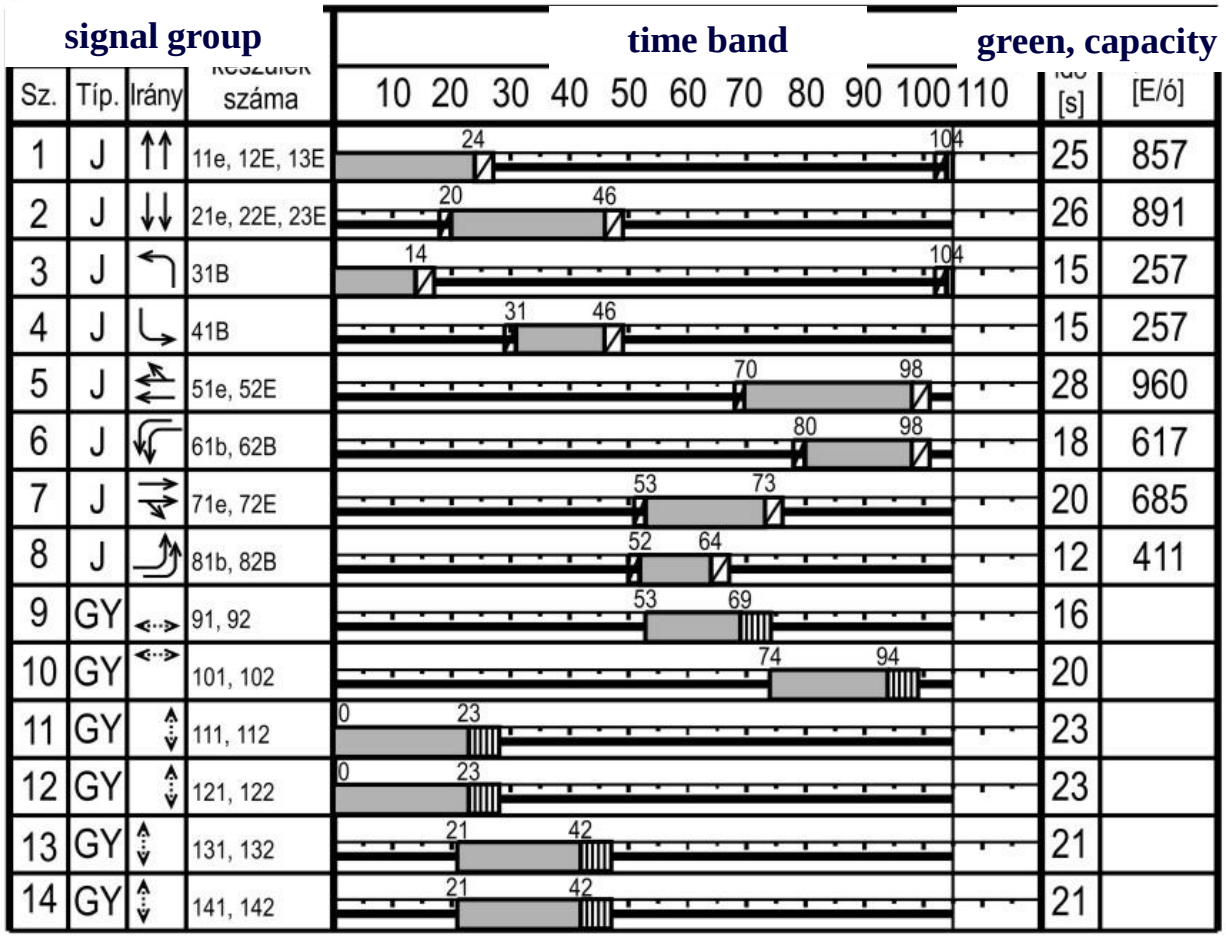
Phase 4.

Phase order

Traffic planning of signalised junctions

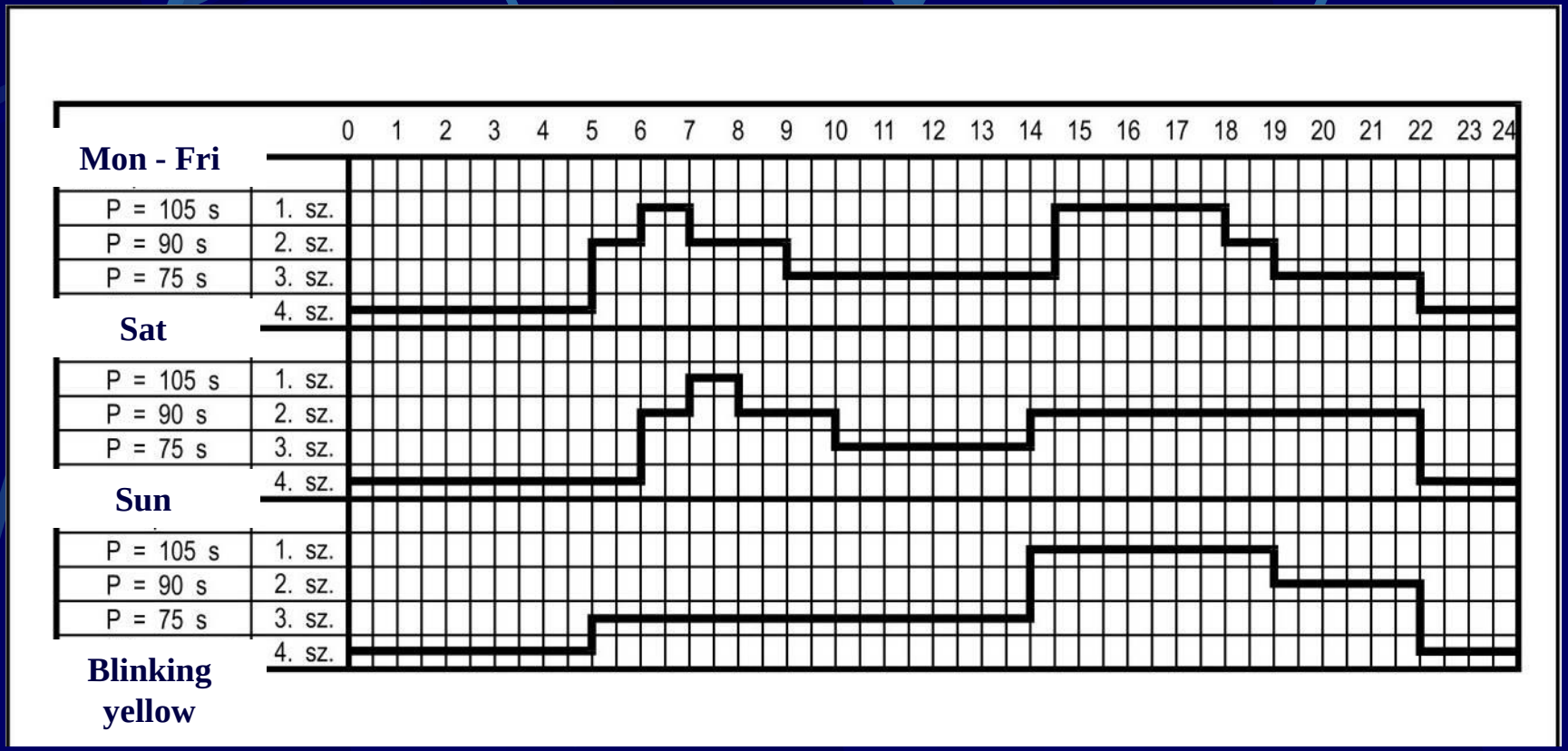
Phase timing plan

P=105s



i.e. row 5. : C = 2 * (28 / 2) * (3600 / 105) = 960 pcu/h

Traffic planning of signalised junctions



Fix program plan

Co-ordinated signalised traffic control

Co-ordinated signalised traffic control:

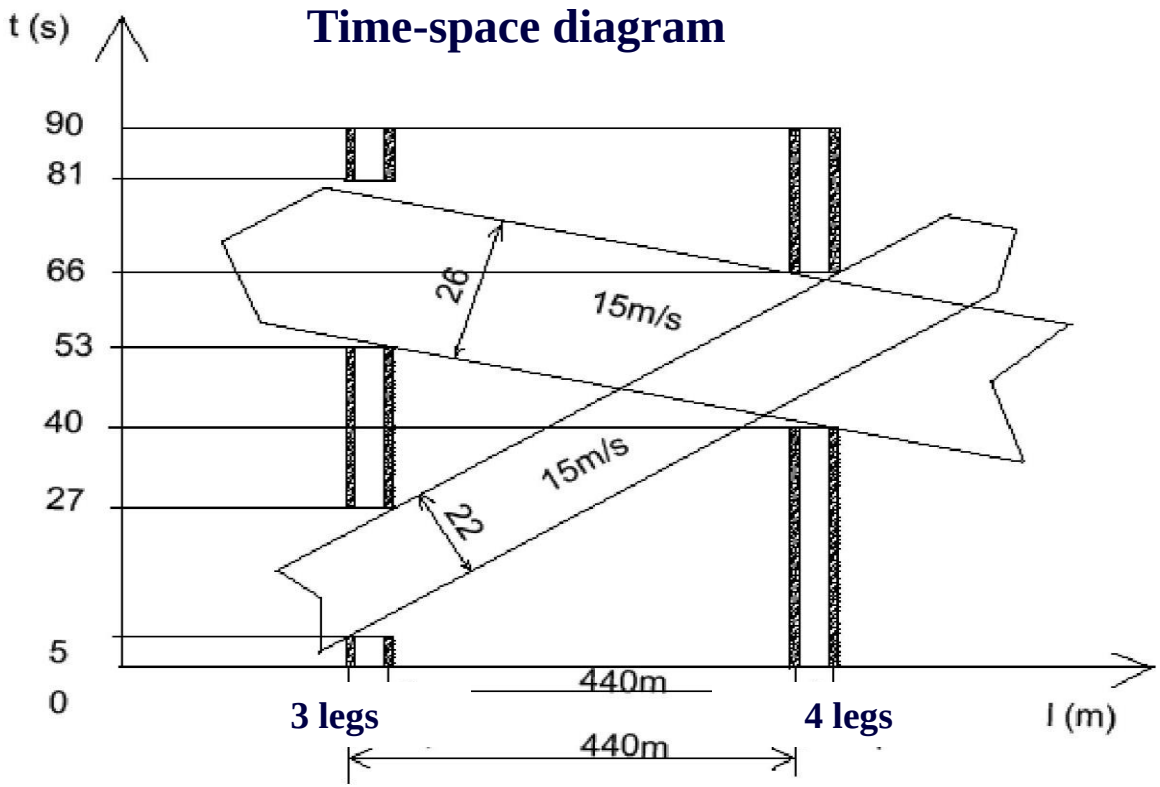
- **ensures continuous traffic flow in the main direction,**
- **decreases time losses in junctions,**
- **reduces harmful environmental effects.**

There is a need for capacity reserve in the junctions (15 – 25 %).

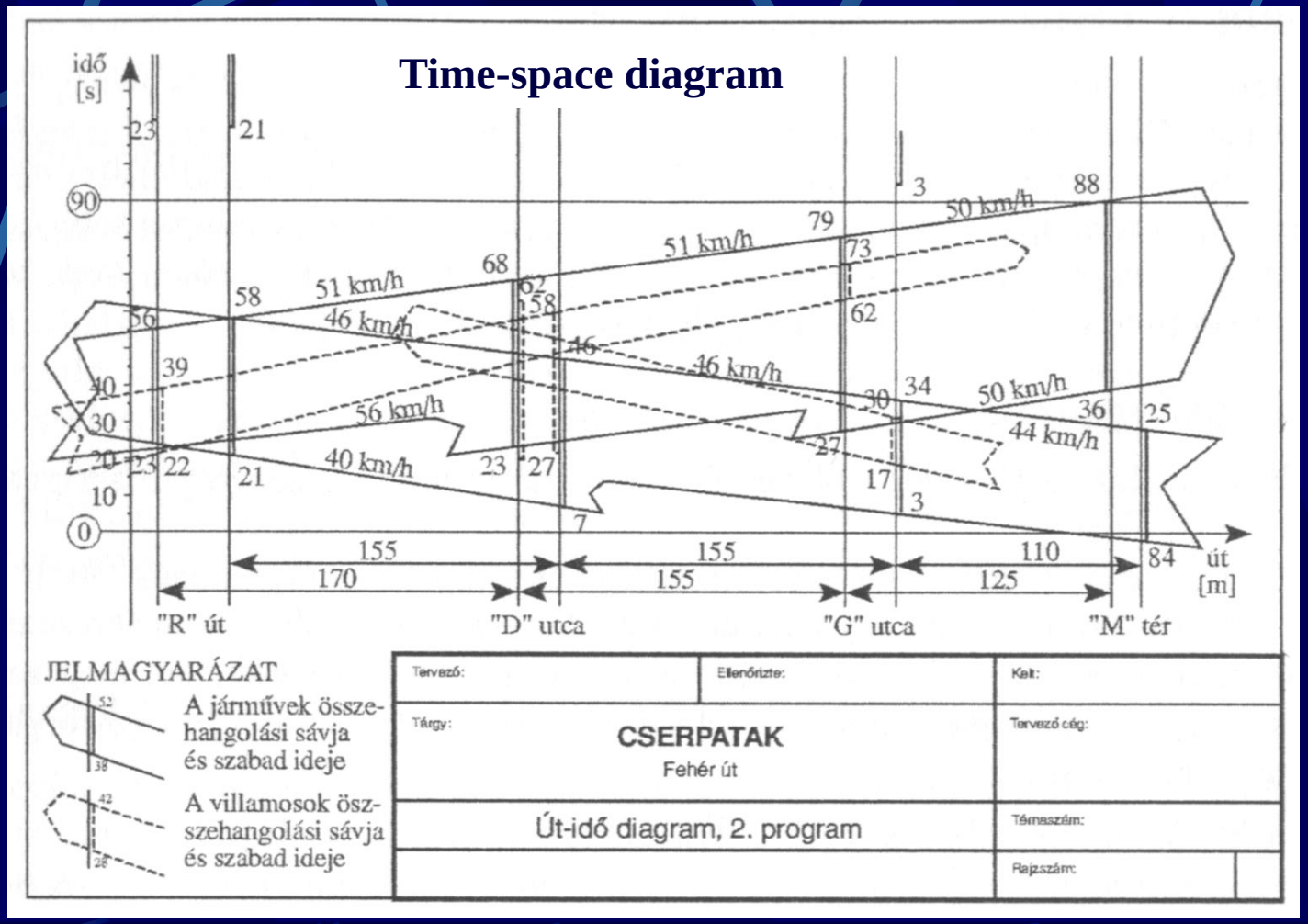
The co-ordination is necessary if distance of junctions is less than 300 m.

A dedicated pedestrian crossing must be included.

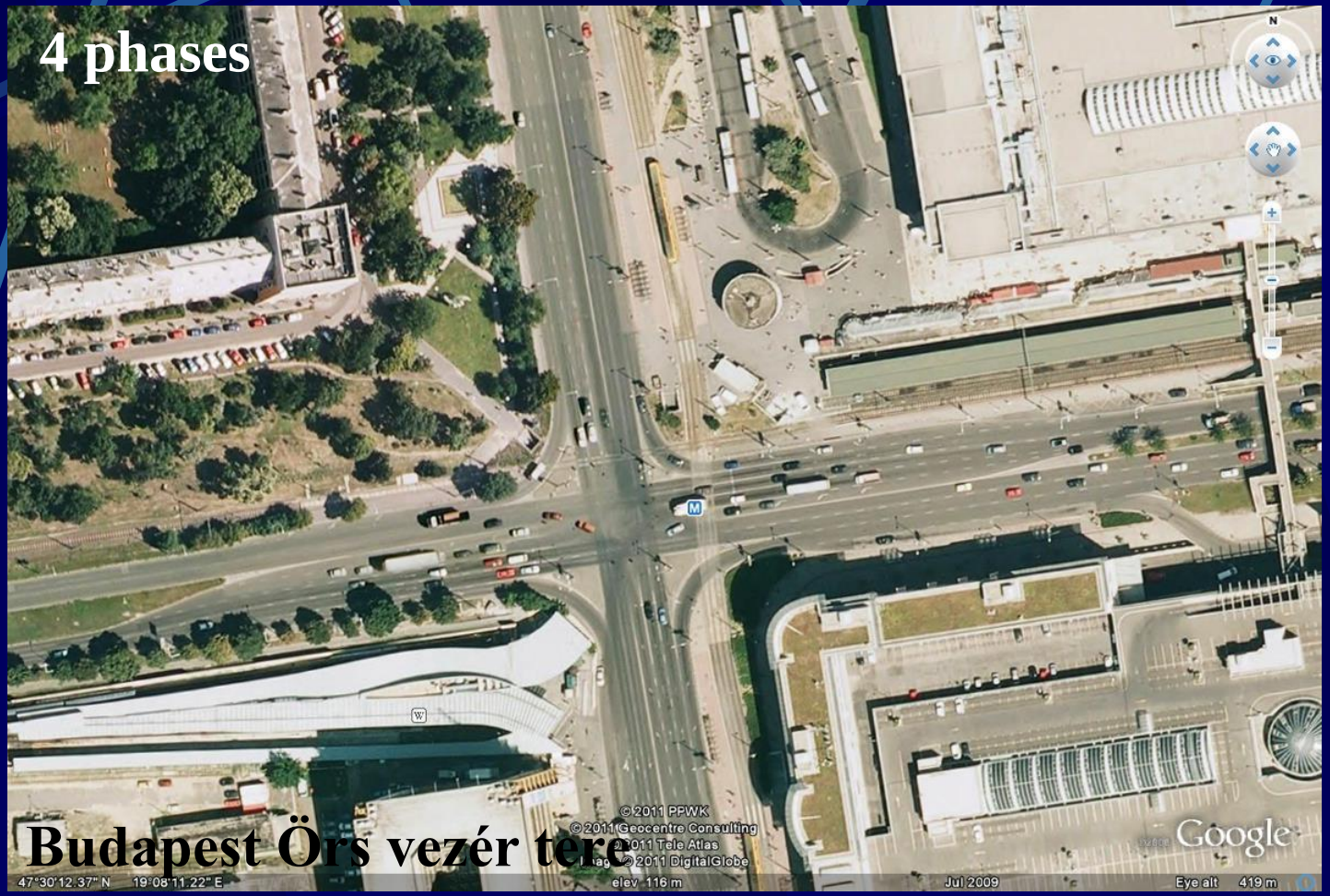
Co-ordinated signalised traffic control



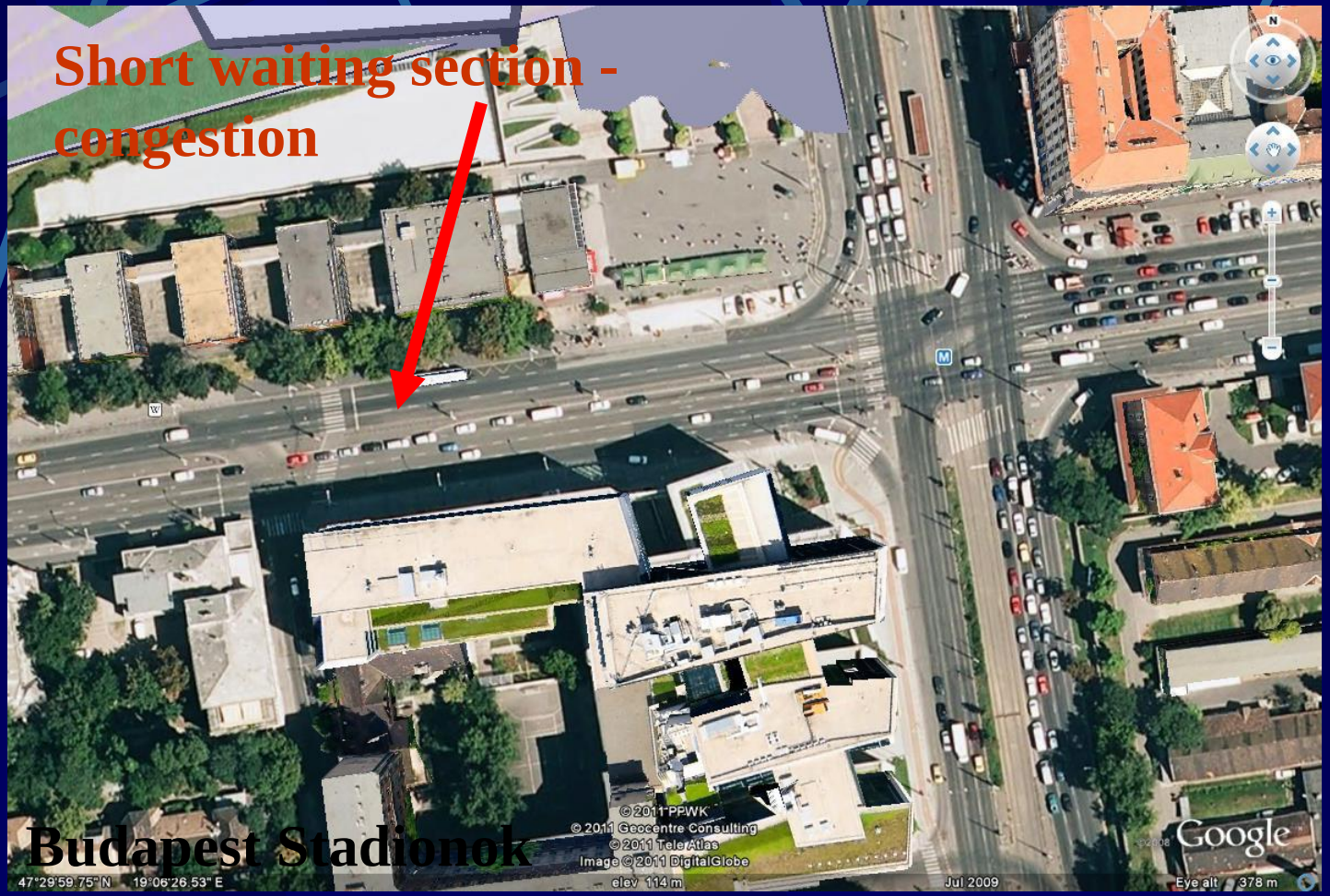
Co-ordinated signalised traffic control



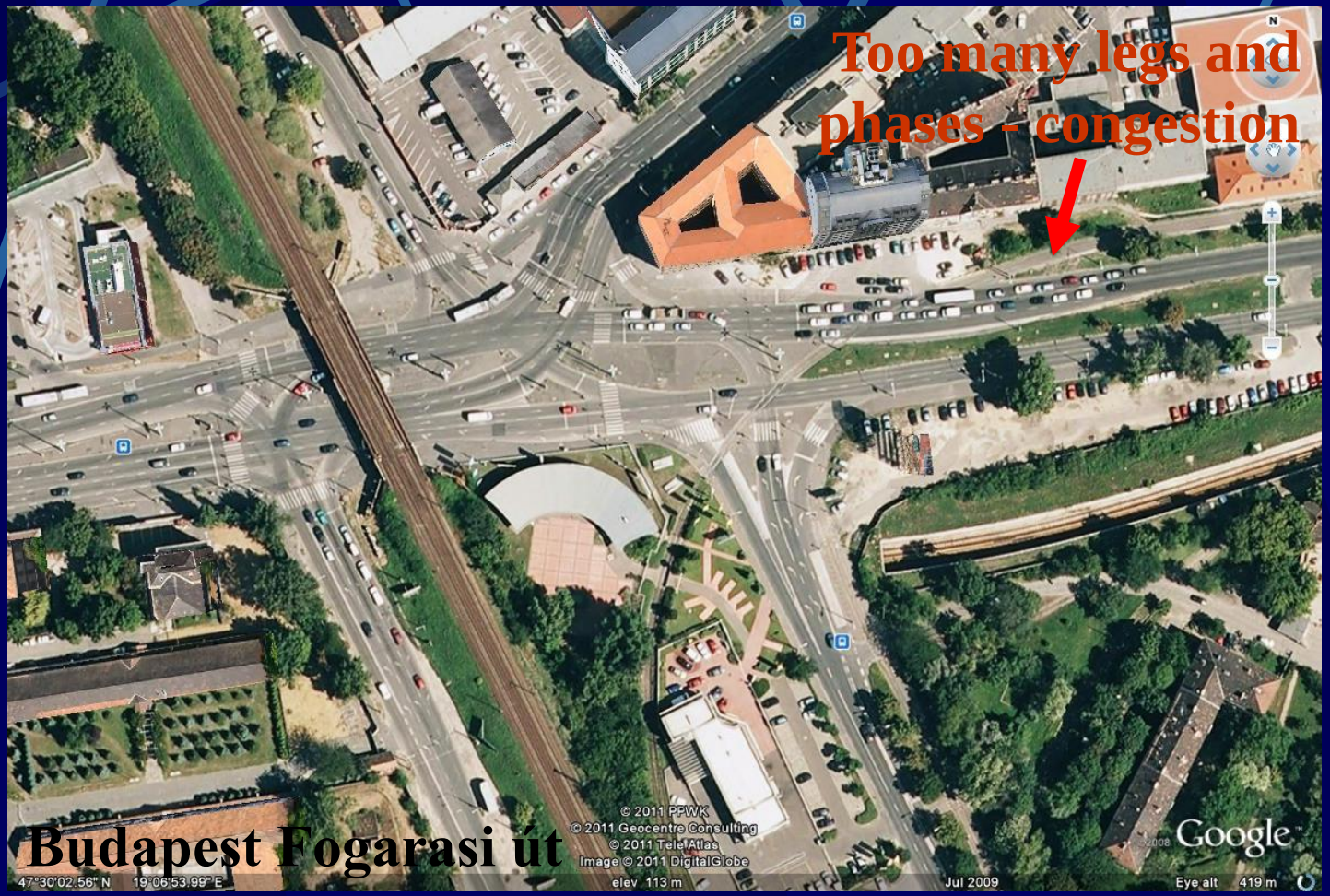
Examples of signalised junctions



Examples of signalised junctions



Examples of signalised junctions



Adaptive traffic control systems

The adaptive traffic control system is a real time control system depending on the traffic situation.

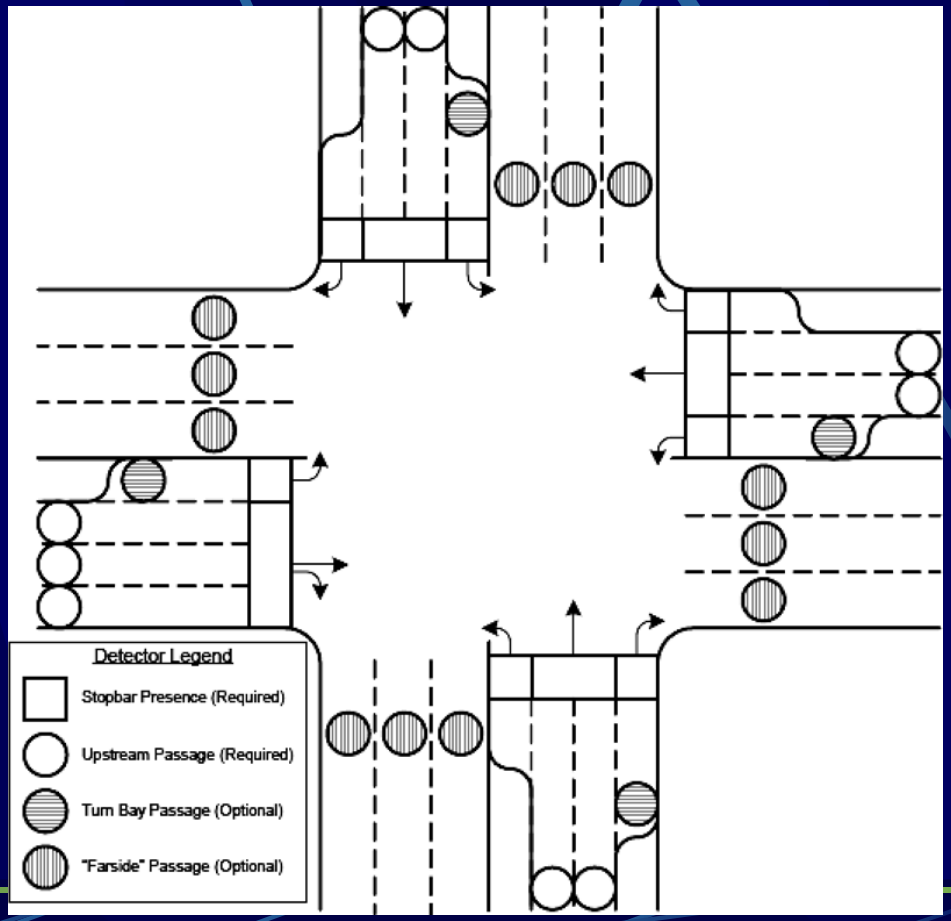
There is a network of area-wide traffic sensors for monitoring.

The aim of the dynamic control algorithm can be the minimum of time losses or the waiting queues.

The system calculates optimal time periods and varies the green times within every time period, moreover co-ordinates some main streams.

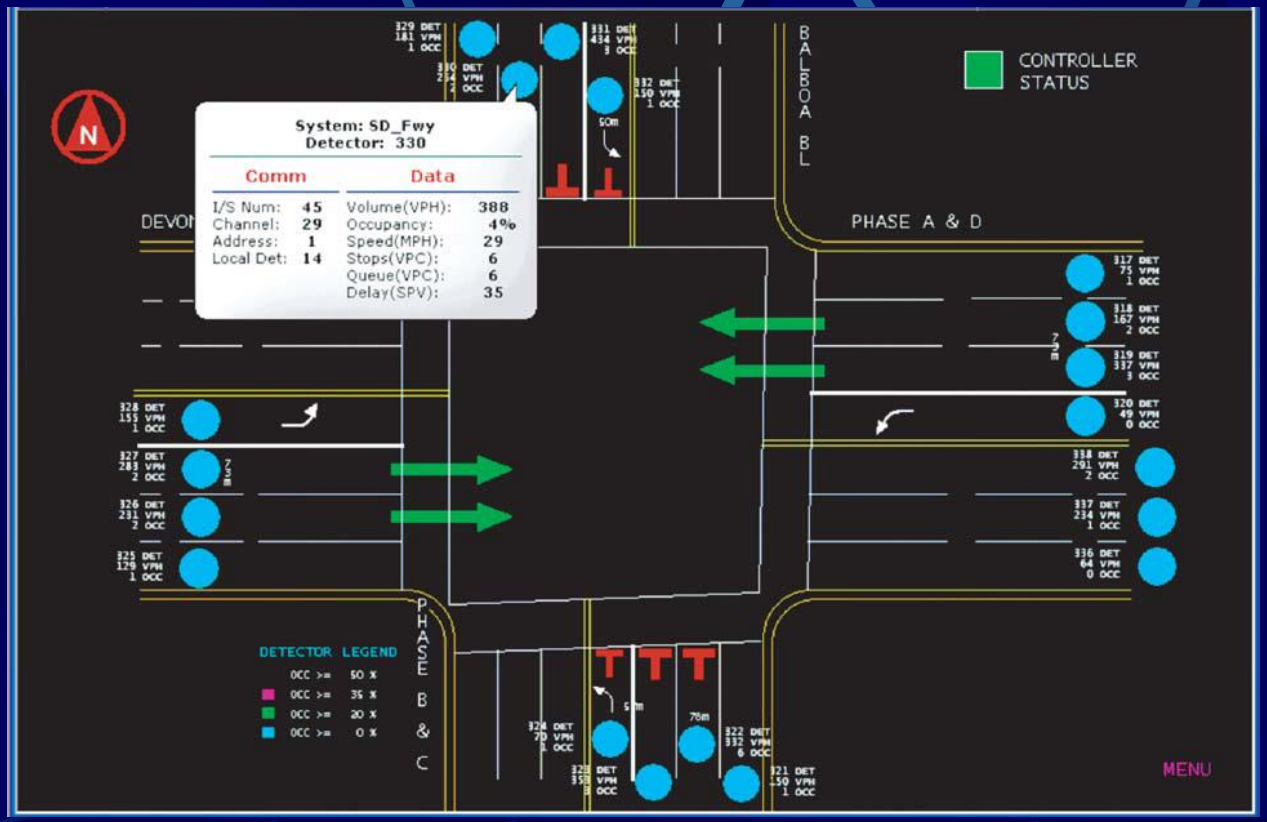
Adaptive traffic control systems

Sensor placing in the intersection



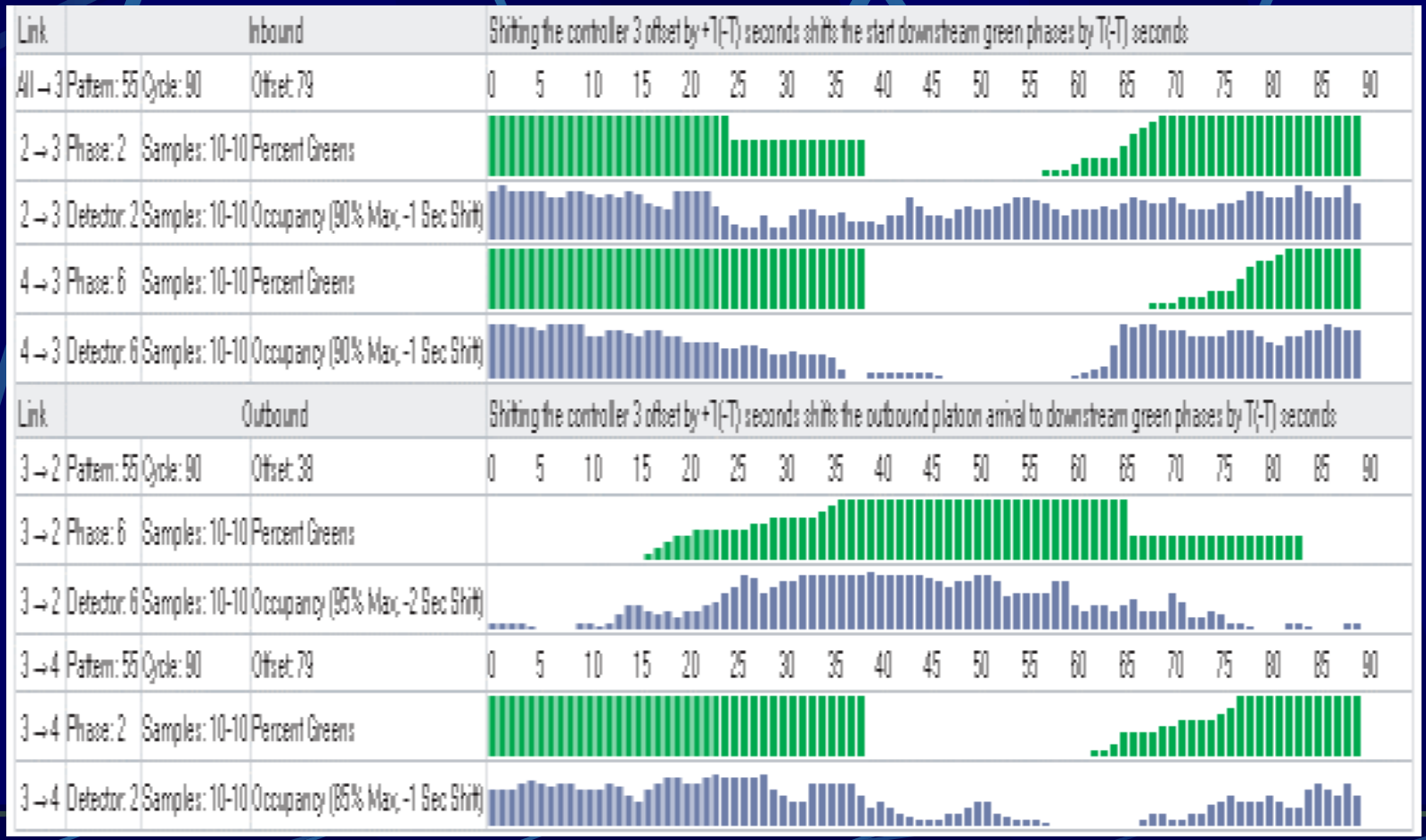
Adaptive traffic control systems

Central acquisition of sensor data

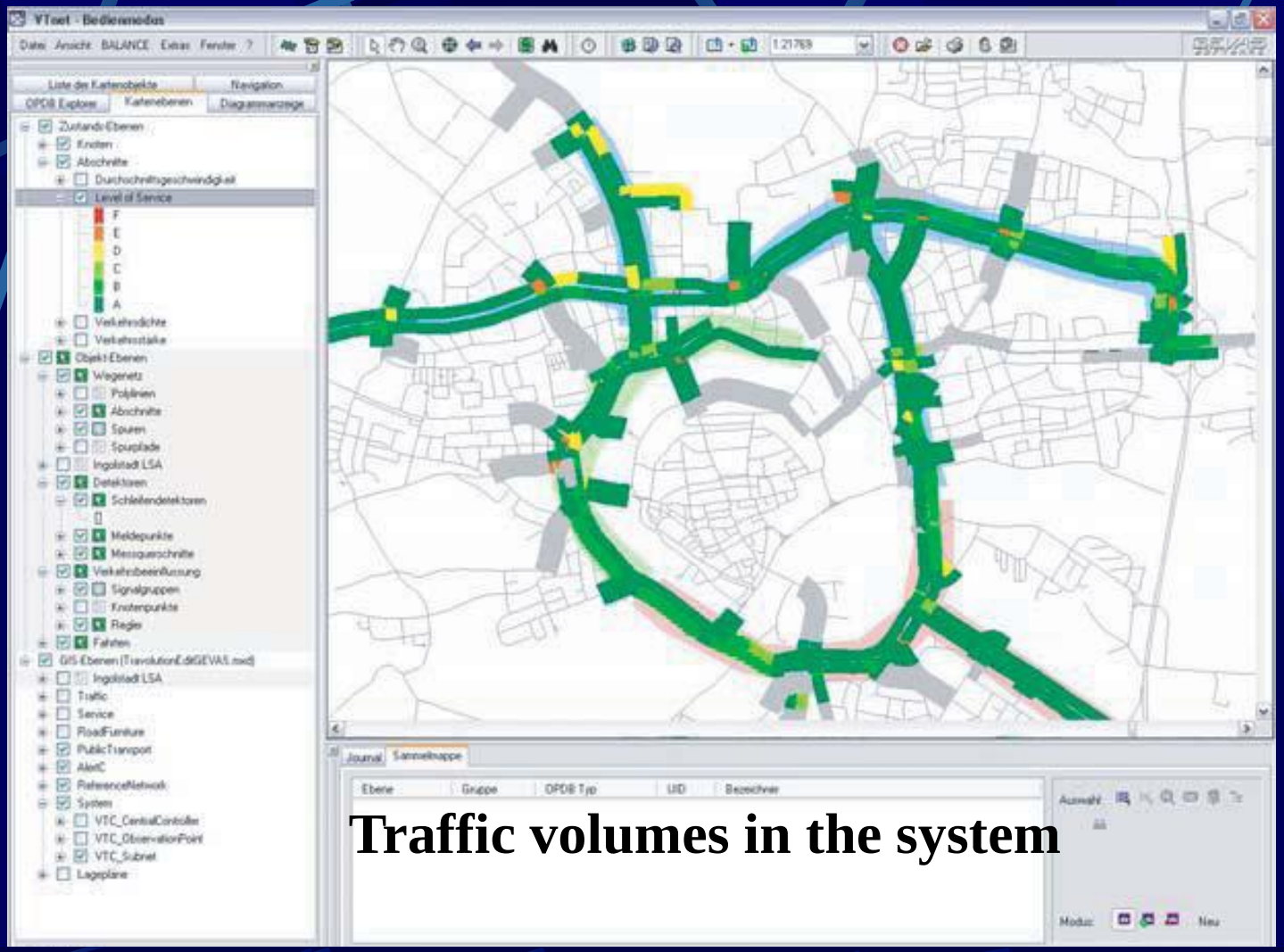


Adaptive traffic control systems

Shifting the beginning of green times eases the saturation



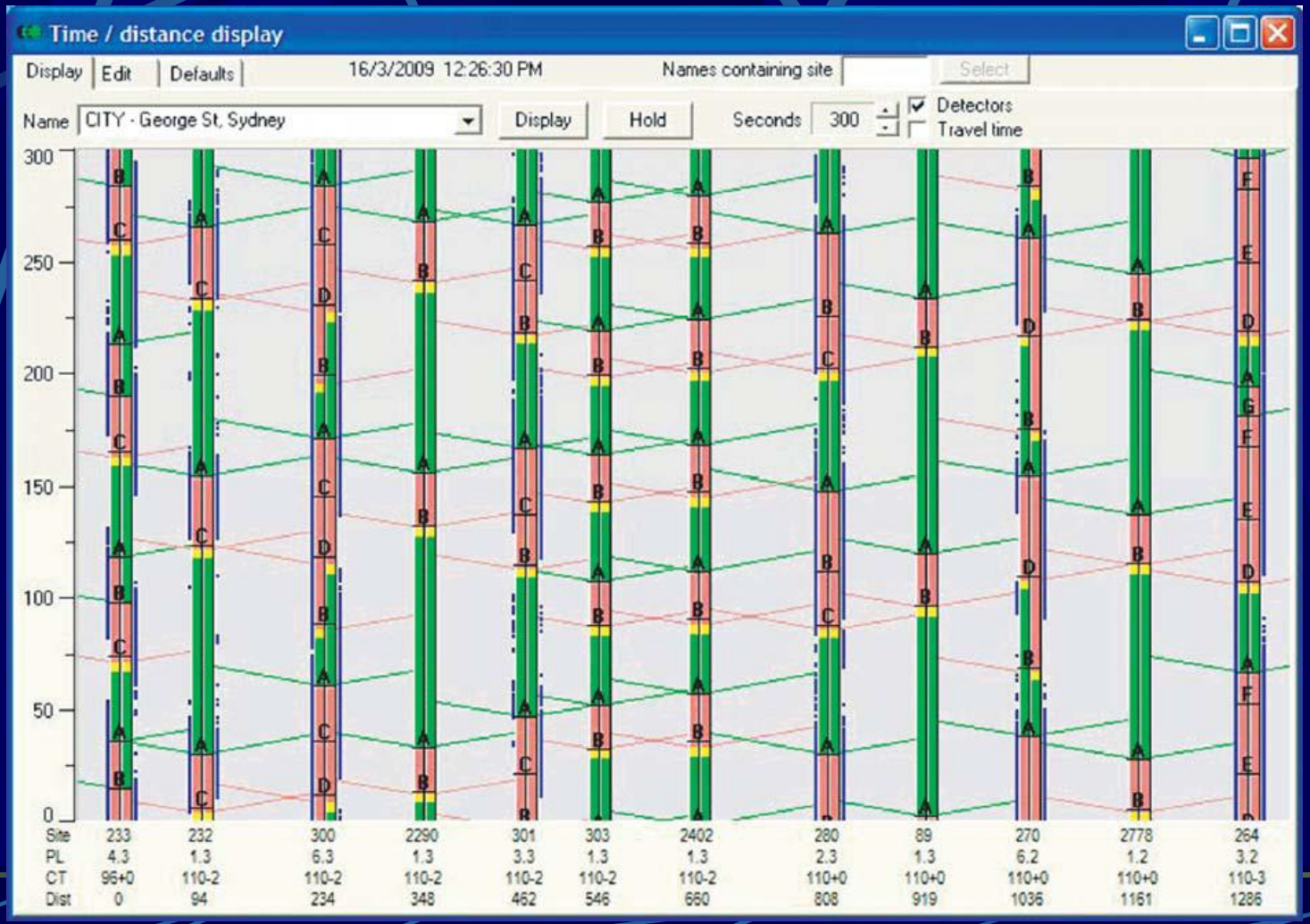
Adaptive traffic control systems



Traffic volumes in the system

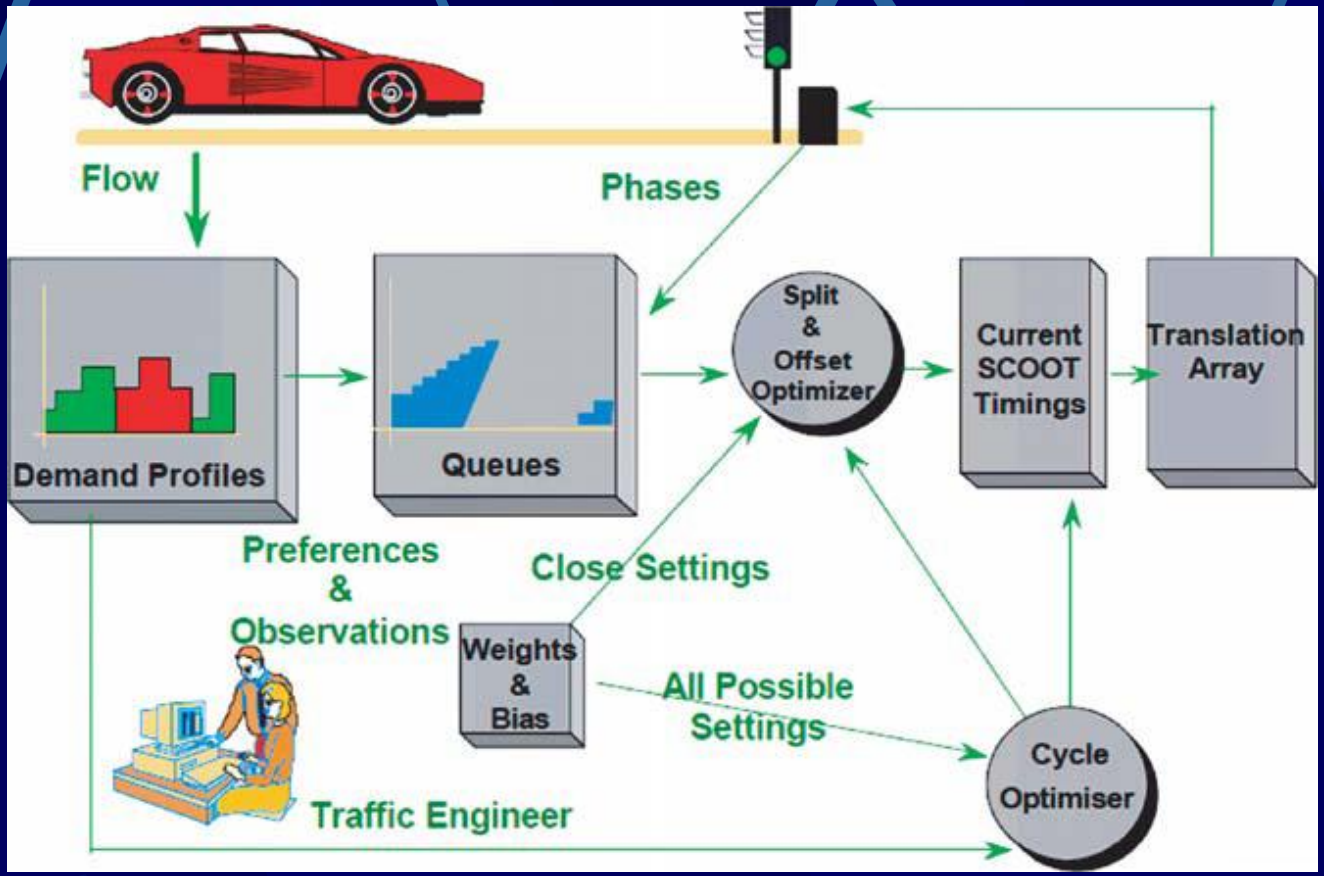
Adaptive traffic control systems

Time-space diagrams of a network level co-ordination

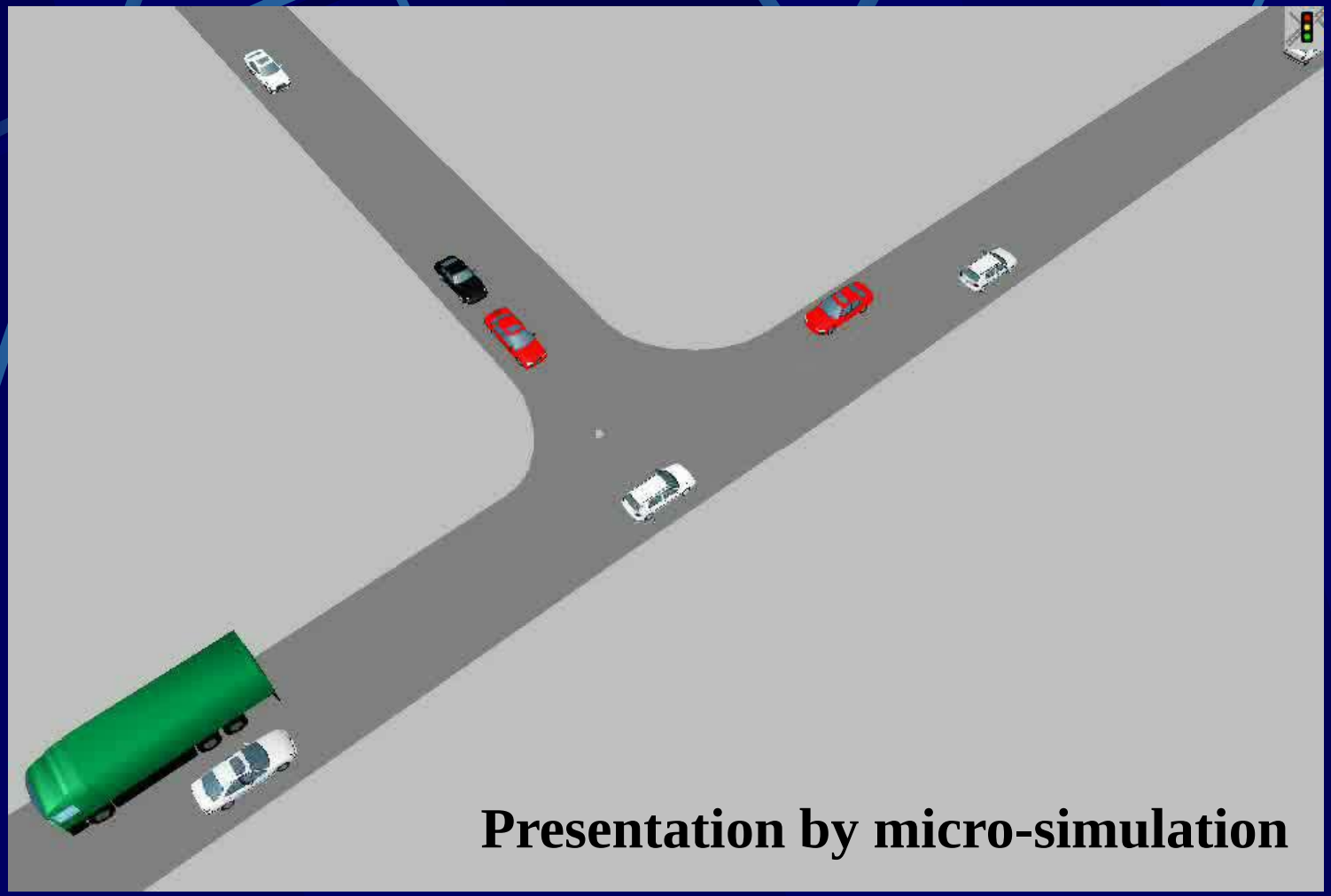


Adaptive traffic control systems

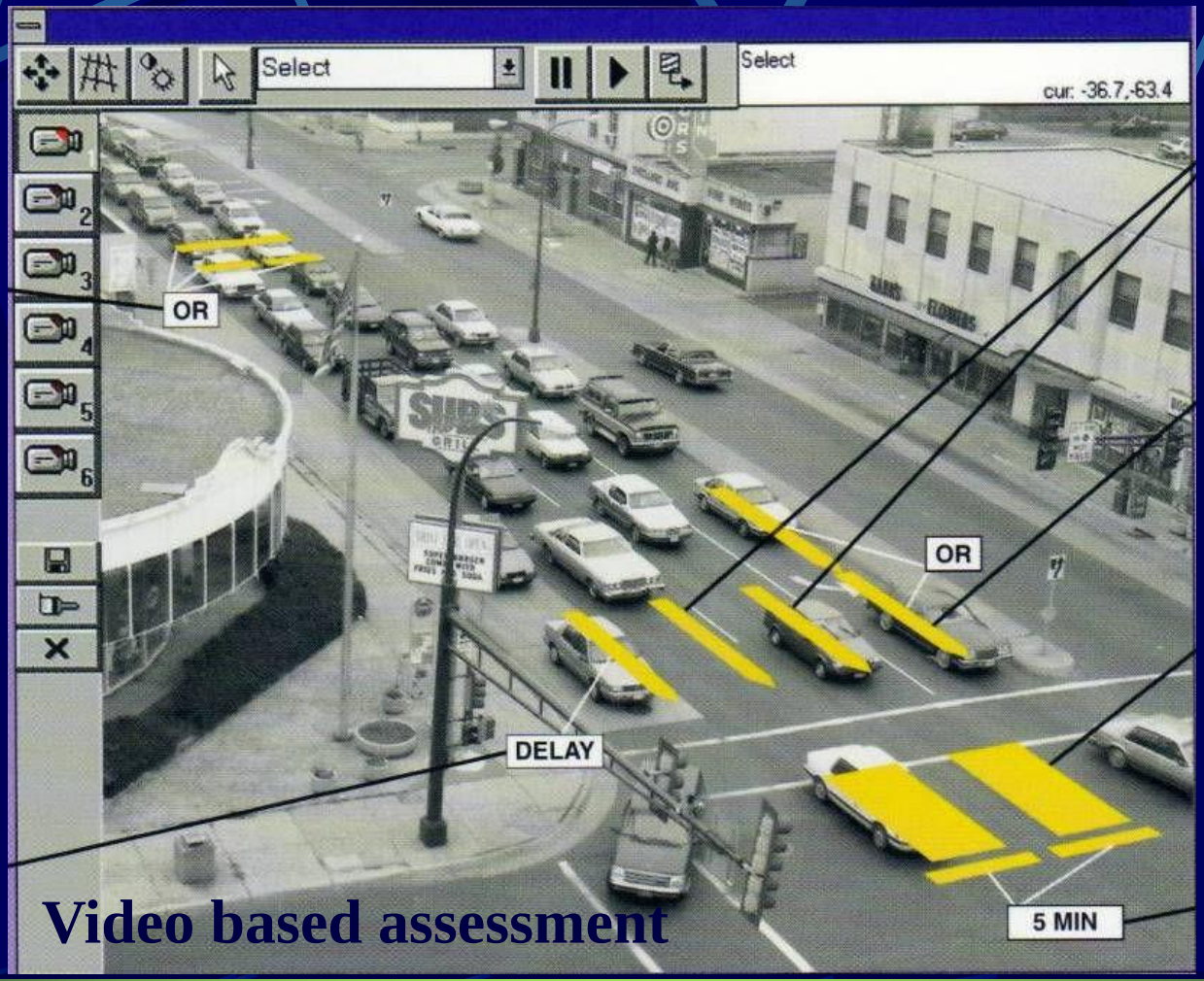
The adaptive system from demand to control



Adaptive traffic control systems



Adaptive traffic control systems



Video based assessment

Summary

Planning conditions are: volume and classification of traffic, its changes in time, the safety situation (accidents), local circumstances.

Capacity must be calculated for each phase and together.

Intermediate times must be calculated for every pair of possible conflicts.

For signal co-ordination there is a need for capacity reserve in the junctions.

The adaptive traffic control system is a real time control system depending on the traffic situation.

Thank you for your attention!

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