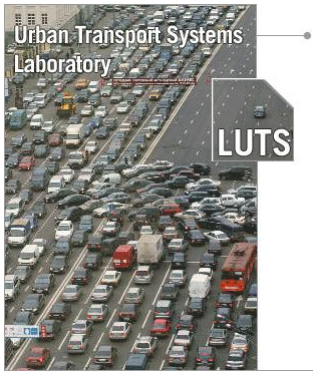
CIVIL-349 -Traffic engineering



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EPFL

Urban Transport Systems Laboratory (LUTS)

Preliminaries

- **Format**: 2.5 hours of lecture per week + 1.5 hour of exercise-laboratory per week (on average)
  Lectures: Thursday 2.00 – 6.00 pm, **Meeting room: ODY-10020**

- **Instructor in Charge**
  Prof. Nikolas Geroliminis
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  The team: Marko Maljkovic (marko.maljkovic@epfl.ch, GC C2 385)
  Amélie Menoud (amelie.menoud@epfl.ch)
  Pablo Vallbona Fernandez (pablo.vallbonafernandez@epfl.ch)
  Batuhan Avci (batuhan.avci@epfl.ch)
  Marko Šušnjar (marko.susnjar@epfl.ch)

- Office Hours for assistants: Wednesday 12:00-13:00 (and by appointment)
- *Office hours is an optional time which give students the opportunity to ask in-depth questions and to explore points of confusion or interest that was not fully addressed in class.

Course Objectives and Description

- Introduce the major elements of transportation systems and create awareness of the broader context
- Develop basic skills in applying the fundamentals of the transportation field
- Understand the key concepts and physics of the transport phenomena
- Connect with real transportation problems
- Be prepared for further study in this field

Course Structure / Grading

Grading

- The final grade will take into account performance in the **final written exam** as well as **team projects (laboratories)**, **midterm exam** and **homeworks**.
- The final written exam will last 165 minutes and will involve questions focusing on the different topics covered during the course and the laboratories.
- The midterm exam will have a similar style and last 75-90min.
- Exercise sessions involve some problem solving with the teaching assistants, they do not require any effort outside classroom and they do not directly contribute to the final grade.

Midterm exam
November 6 (2:15-3:45pm)

Final exam
December 18 (2:15-5:00pm)

Type	Fraction
Homeworks	0%
Midterm	30%
Final Exam	40%
Laboratories	30%
Total	100%

Grading (II)

Lab grades are a function of:

- Correctness of the solution approach
- Quality of the analysis
- Clarity and neatness of written section

Late Assignments: Will only be accepted under extraordinary circumstances

Exam grades are a function of:

- Correctness
- Quality of analysis

Great Expectations

I am expected to….

- Teach
- Be fair and kind with all of you
- Give you feedback on how you are doing in a timely fashion
- Be in my office when we have a meeting or office hours

You are expected to…

- Learn
- Attend lectures and participate
- Do the problem sets
- Not be rude if possible – sleeping, cell phones, using laptops for chatting, texting girlfriend/boyfriend etc.

Academic Integrity/Plagiarism

- Presenting another's ideas, words or pictures as your own, or giving unauthorized help on assignments or exams
- Students who attempt to obtain unearned academic credentials weaken the value of the EPFL degrees earned by the honest ones.
- Plagiarism and Cheating of any kind will result at least in a zero grade for that assignment (and may be subject to stronger penalties.
- In all of your assignments, including your homework or labs, you may use words or ideas written by others but only if you have fully identified the original source and extent of your use of the words or ideas of others that you reproduce, in the form of a footnote.

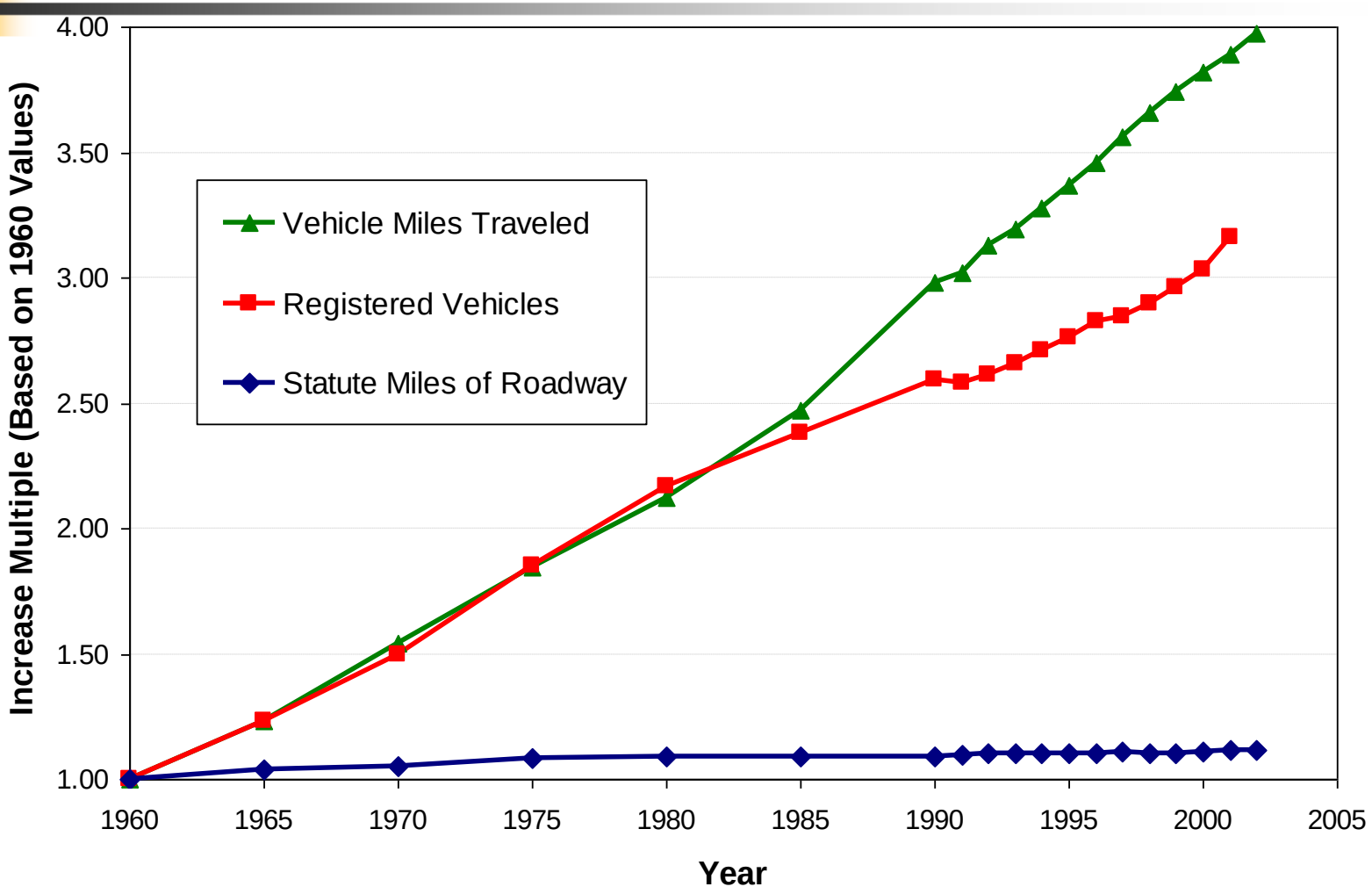
TSE EXAMPLES

- NO-RULE TRAFFIC
- TRAFFIC OPERATIONS
- MULTIMODALITY
- MODELING

If you build it….

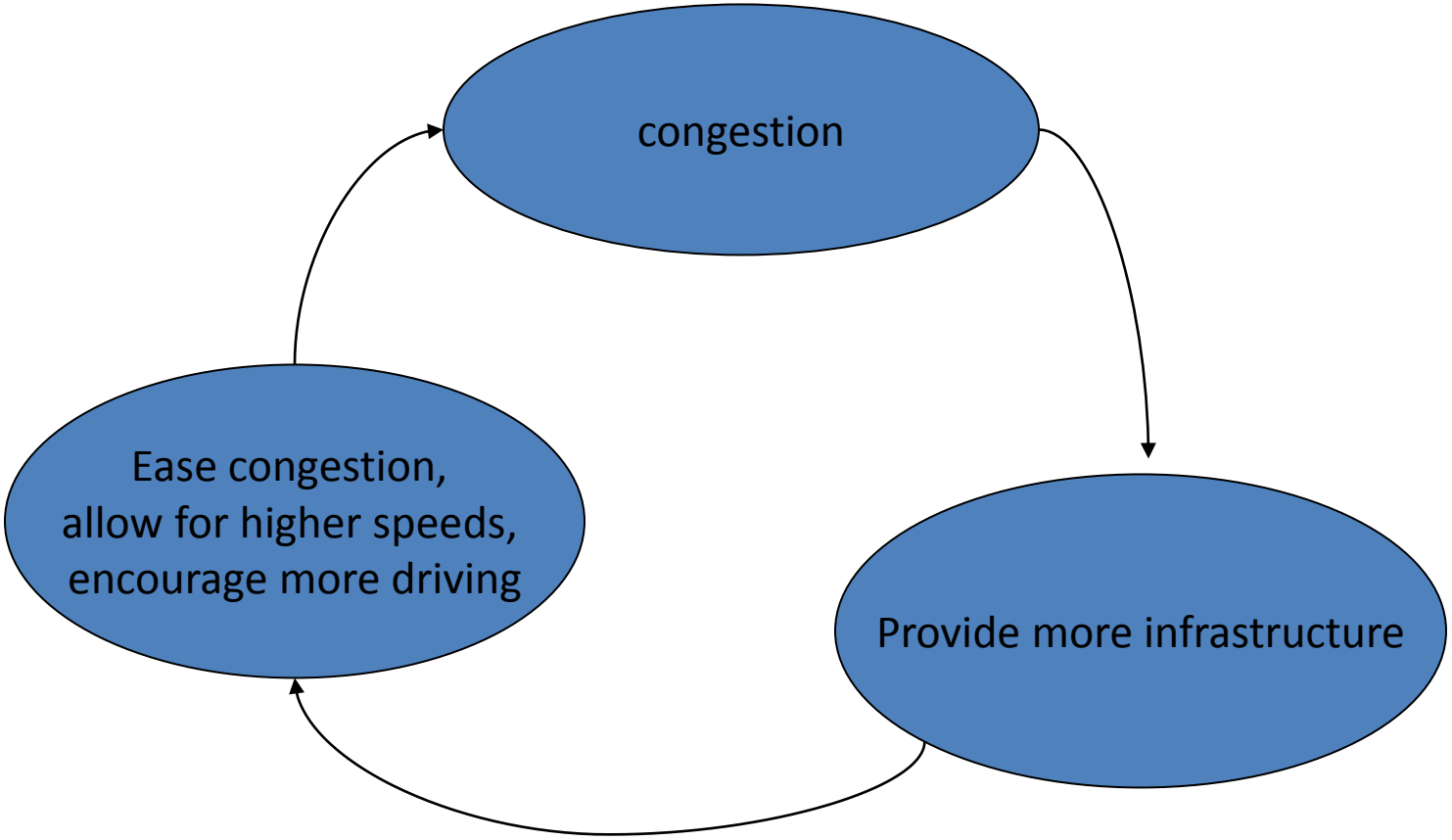
They will come….

Road Use Growth



From the Bureau of Transportation Statistics, *National Transportation Statistics 2003*

Infrastructure development is not the only answer



The Transportation Engineering Challenge

- To safely and efficiently move people and goods
- Not just by designing and building the transportation infrastructure, but by managing the infrastructure and demand
- Design a transportation system that is sustainable

Intelligent Transportation Systems

- Our ability to do this has developed dramatically with electronic sensors and communication
  - Quantify congestion and compare congestion costs to rationalize investment
  - Use cost to distribute capacity rather than delay
  - Automatically detect and avoid dangers
  - Improve security
  - Operate more efficiently

CLASS THEMES

- **Transportation Systems and Mobility**

Mobility – Activities - Land Use, Classification-Hierarchy, Multimodality

- **Traffic monitoring**

Observation, Measurement, Sensing Techniques; the collection and interpretation of transportation data

- **Basic Assessment Tools**

Predominantly graphical tools useful for understanding details of transport operations; common properties of traffic streams (flow, density and speed)

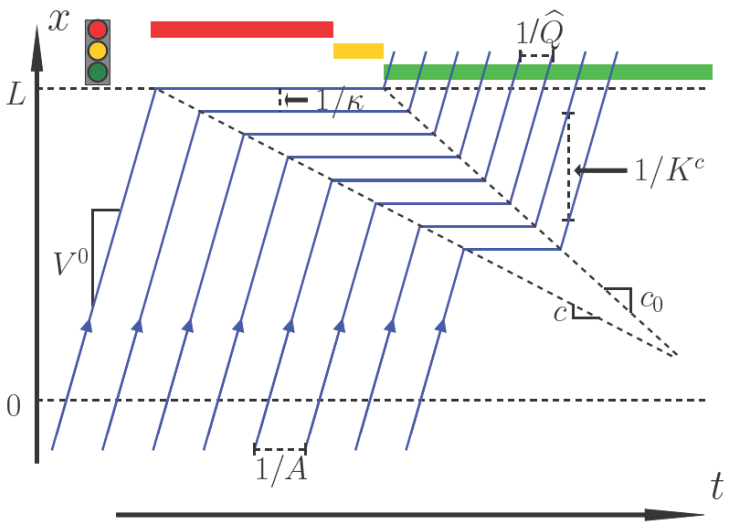
- **Modeling and Operations**

Relations between properties of traffic streams and spatio-temporal models of congestion, Traffic flow modeling, Control and capacity of transport systems, car-following models, shockwave theory

- **Design of multimodal systems**

Urban Policy, Case Studies, Intro to bus operations

CLASS THEMES



Specialties in transportation

- Planning
- Design
- Construction and maintenance
- Traffic Operations

Planning

- Forecast the impact of the project upon the system (e.g., transportation, environment)
- Setting up the specifications of the project
- Determining benefits and costs
- Interact with the decision makers to achieve final decisions

Design

- Involves the specification of all the features of the project so that it can be built.
- geometric design (horizontal and vertical)
- pavement design
- determination of right of way, drainage structures, fencing, etc. (considering the users of the system)
- part of the design process is the production of construction plans

Traffic operations

Its objectives are related to using the facility in the most efficient way. It involves:

- the use of analytical models to determine the most efficient way to operate the facility
- the use of monitoring devices to determine actual conditions and level of service
- the use of devices to implement control strategies

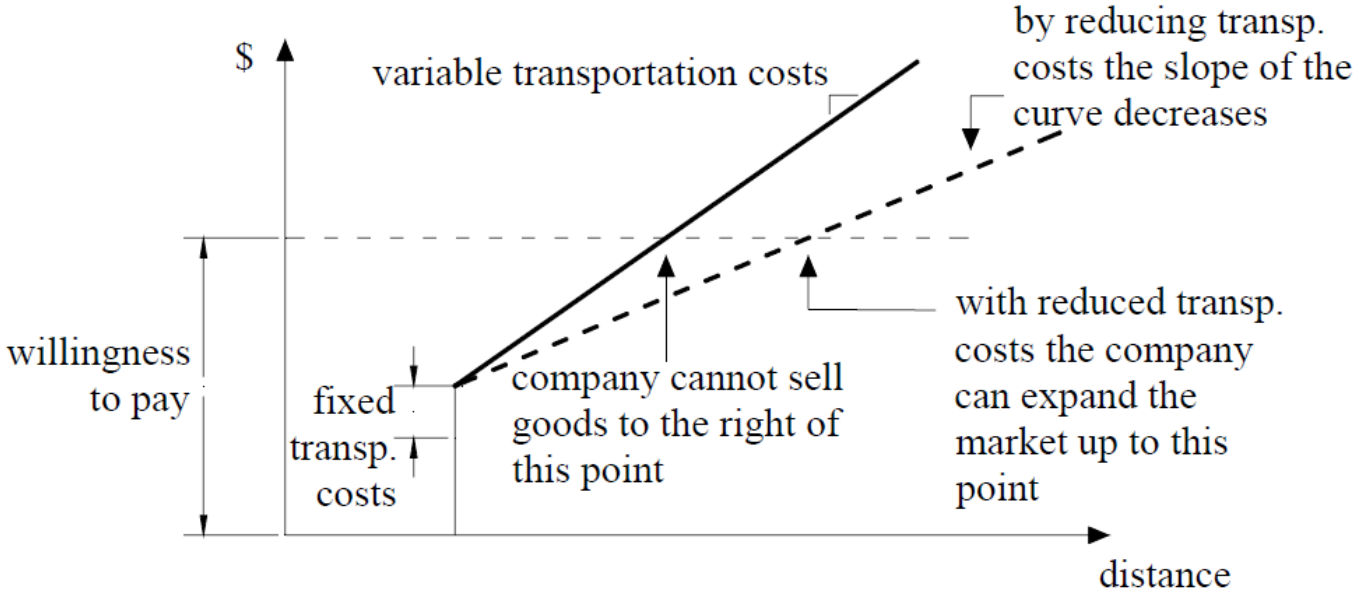
Components of the transport system

- Physical facilities: streets, highways, ports, railroads.
- Fleets of vehicles: trucks, passenger cars, vessels….
- Operating bases and facilities: maintenance facilities,
- Organizations
  - Facility oriented: involved in planning, design, construction, maintaining and operating fixed facilities
  - Operating organizations (carriers): railroads, airlines, shipping companies, private individuals
- Operating strategies: routing, scheduling, traffic control

What Transportation Systems do? (Advantages)

Transportation might affect time/place utility of goods.

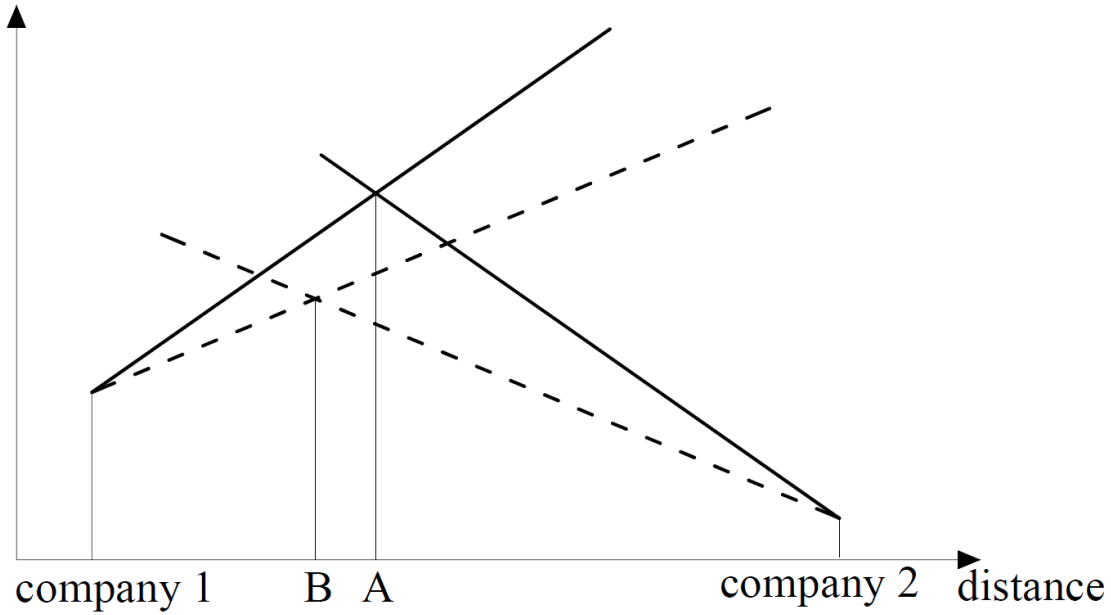
- If we can increase the value of a good by reducing its transportation time then we obtain “time utility” (i.e. fast delivery of newspaper)
- We might expand the market of some goods by reducing their transportation cost (place utility)



What Transportation Systems do? (Advantages)

If we reduce fixed transportation costs:

- Overall cost reductions
- Expanded market
- OR induce competition

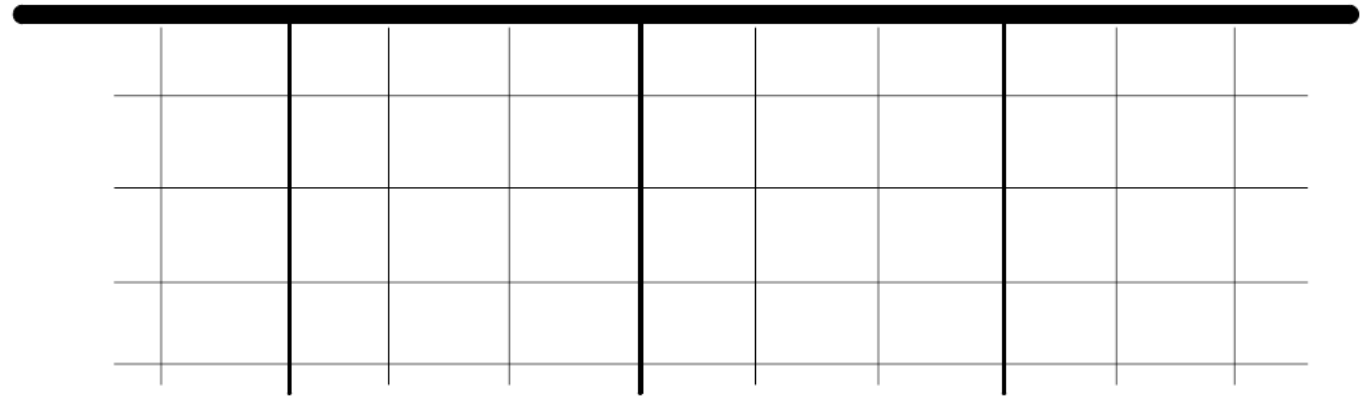


What Transportation Systems do? (Disadvantages)

Resource Consumption	Alterations of the environment
• Energy consumption (fossil fuels) • Land consumption • Consumption of raw materials • Safety	• Air pollution • Water pollution • Noise • Aesthetics • Disruption of animal habitats • Disruption of human habitats

How Transportation Systems work?

Hierarchy: we try to focus trips on the high-cost facilities to save lifecycle costs. However, there is the penalty of circuity: if we only build one facility there would be huge detours.



freeway
arterial street
local street

Hierarchy in Transportation Systems

- In scheduled transportation:
  - One might take the taxi to the airport
  - Then a regional jet to a bigger airport (airline hub)
  - Finally a bigger plane for the transatlantic flight
- In unscheduled transportation:
  - Freeways handle a lot of traffic in an efficient way (they are very expensive)
  - Arterial streets connect local streets to freeways
  - Local streets are very accessible, although not very efficient (they have a low unit cost)

The role of hubs in TS

A hub can reduce the number of city pairs from N^2 to 2N.