Lecture

Control and Perception in Networked and Autonomous Vehicles

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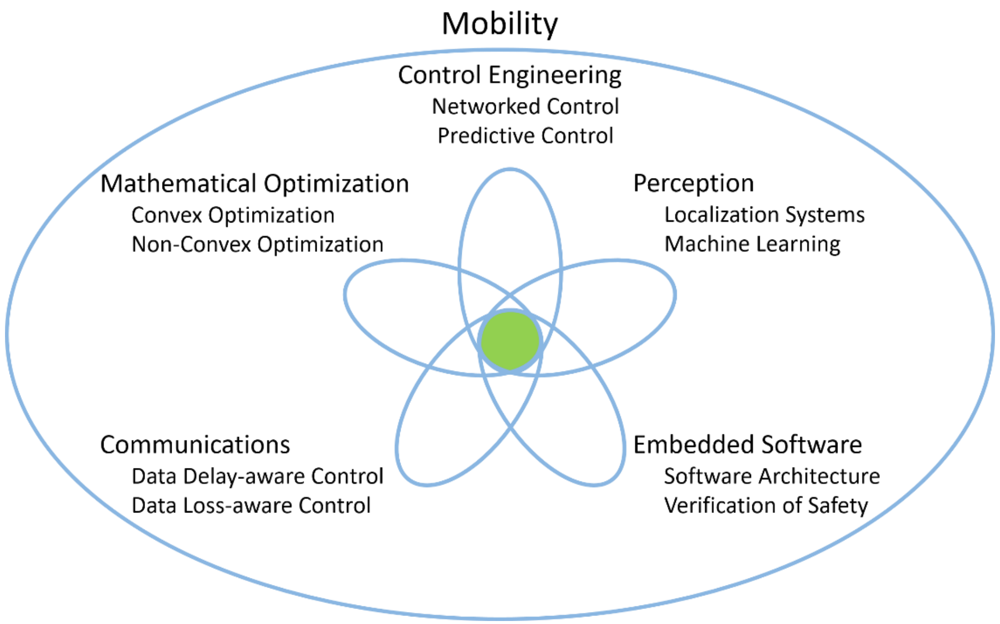
Part 7

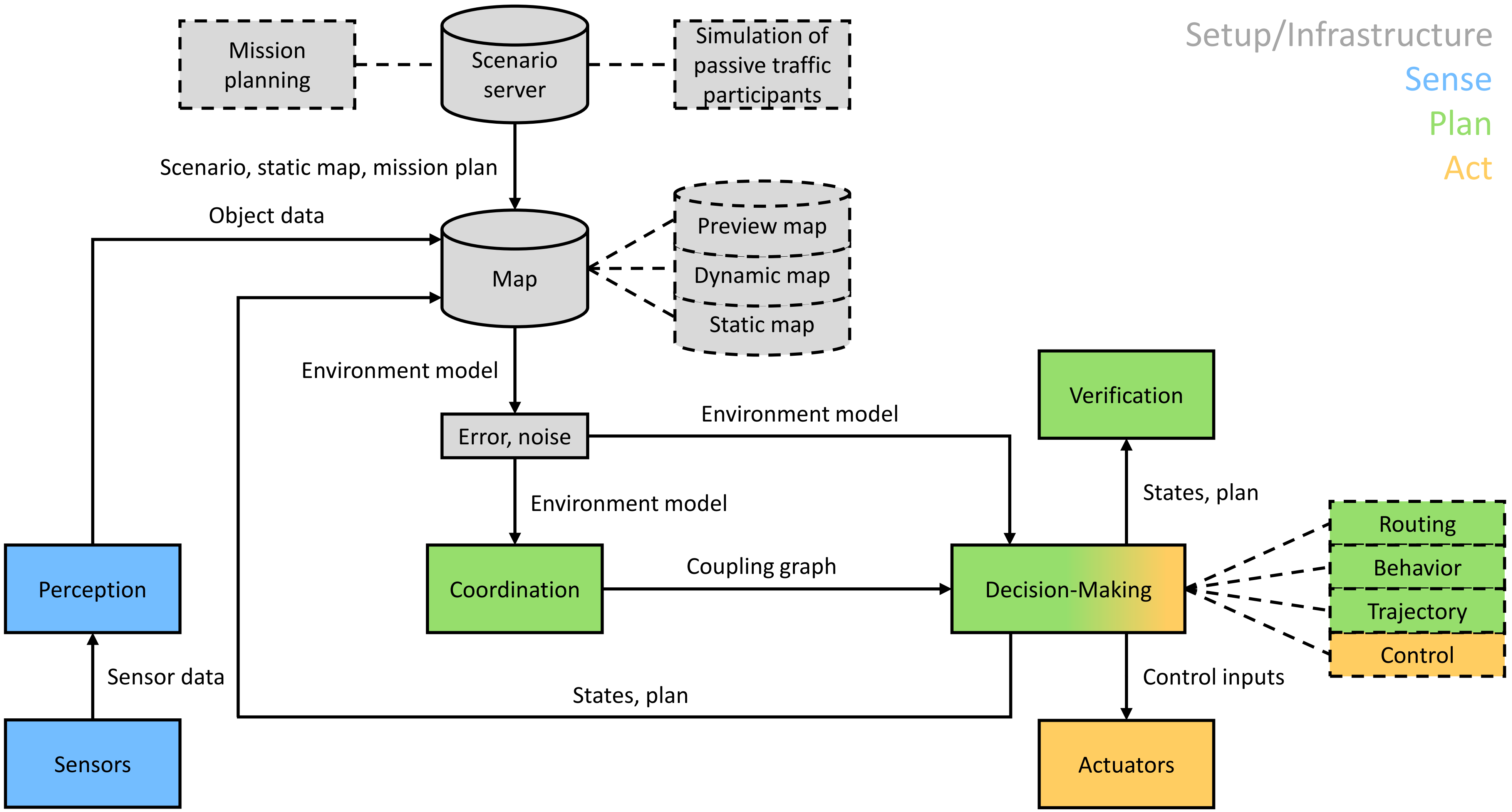
Case Study

Course contents

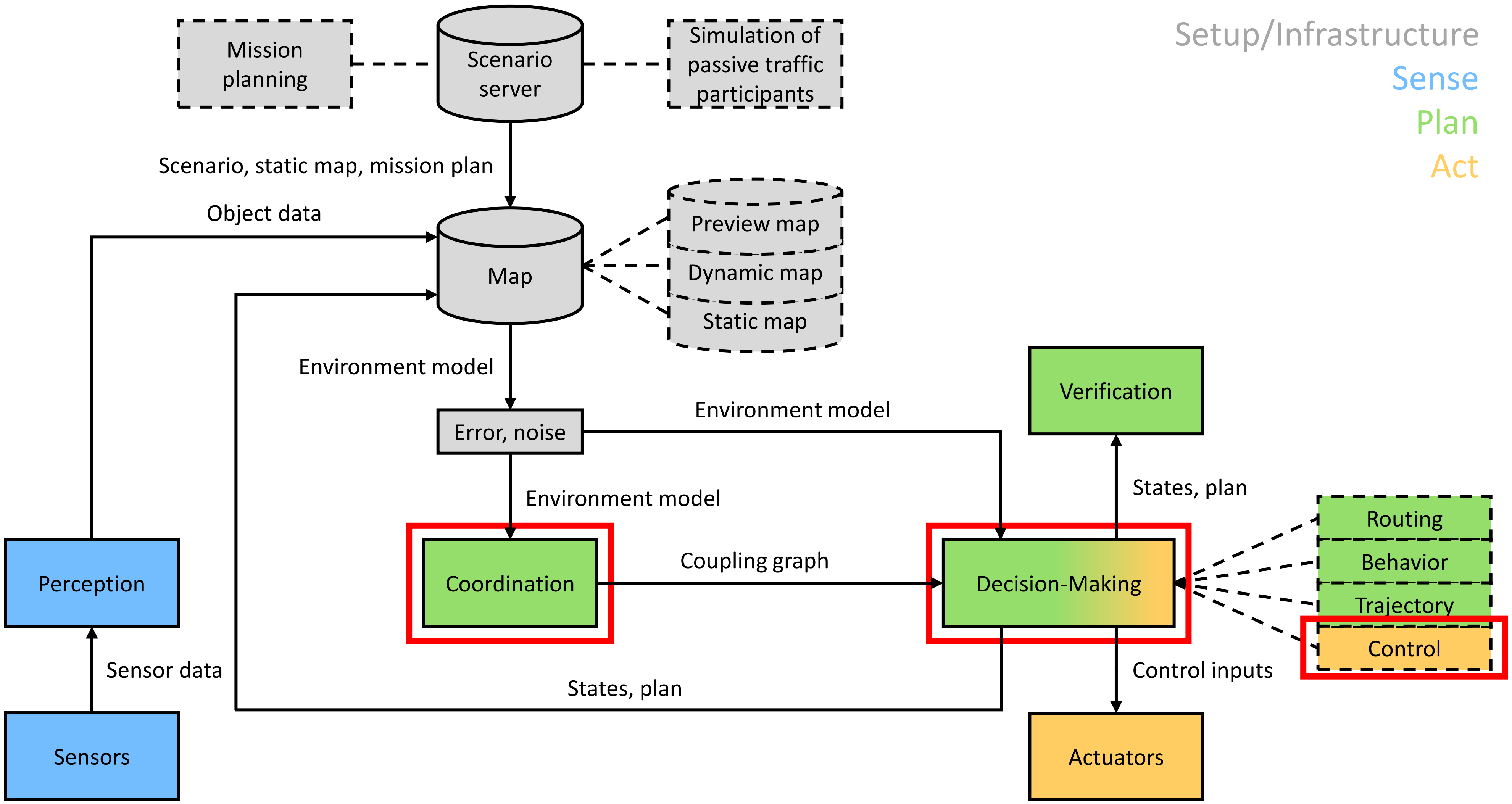
- Dynamic vehicle models
- Control and optimization
- Network and distribution
- Machine perception
- Software architectures and testing concepts
- Case study



CPM Lab architecture



CPM Lab architecture



Informatik 11
Embedded Software
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Literature

- R. Rajamani. Vehicle Dynamics and Control. Springer, 2005.

Further literature (1)

- Many

Further literature (2)

- B. Alrifaee, M. Reiter, J. P. Maschuw, F. Christen, L. Eckstein, and D. Abel. Satellite- and Map-based Long Range Cooperative Adaptive Cruise Control System for Road Vehicles. In IFAC Symposium on Advances in Automotive Control (AAC), 2013.
- CPM Lab papers

Case study

1-D problems

- Speed control, also called Cruise Control (CC)
- Speed and distance control, also called Adaptive Cruise Control (ACC)
- Distance control of multiple vehicles, also called Platoon Control

ACC using PID

- Set speed required in case of Cruise Control
- Integral part required if measurement of leader speed uncertain
- Case of constant set distance

ACC using LQR

- Equations

$$d = x_{\text{leader}} - x_{\text{veh}}, \; d_{\text{ref}} = v_{\text{veh}} \cdot t_{\text{ref}} + d_{\text{min}}$$

$$e = d - d_{\text{ref}}$$

$$e = x_{\text{leader}} - x_{\text{veh}} - v_{\text{veh}} \cdot t_{\text{ref}} - d_{\text{min}}$$

$$\dot{e} = v_{\text{leader}} - v_{\text{veh}} - a_{\text{veh}} \cdot t_{\text{ref}}$$

$$\dot{a}_{\text{veh}} = -{}^{1}\!/_{T} \cdot a_{\text{veh}} + {}^{k}\!/_{T} \cdot a_{\text{ref}}$$

- State space model

$$\dot{e} = \dot{e}$$

$$\ddot{e} = a_{\text{leader}} - a_{\text{veh}} - \dot{a}_{\text{veh}} \cdot t_{\text{ref}}$$

$$\ddot{e} = a_{\text{leader}} + \left(-1 + {}^{t_{\text{ref}}}\!/_{T}\right) a_{\text{veh}} - {}^{k \cdot t_{\text{ref}}}\!/_{T} \cdot a_{\text{ref}}$$

$$\dot{a}_{\text{veh}} = -{}^{1}\!/_{T} \cdot a_{\text{veh}} + {}^{k}\!/_{T} \cdot a_{\text{ref}}$$

Platoon Control using LQR

- Equations

$$d_i = x_{i-1} - x_i,\ d_{\text{ref}} = \text{const.}$$

$$e_i = d_i - d_{\text{ref}}$$

$$e_i = x_{i-1} - x_i - d_{\text{ref}}$$

$$\dot{e}_i = v_{i-1} - v_i$$

$$\ddot{e} = a_{i-1} - a_i$$

$$\dot{a}_i = -{}^{1}\!/_{T} \cdot a_i + {}^{k}\!/_{T} \cdot a_{i_{\text{ref}}}$$

- State space model

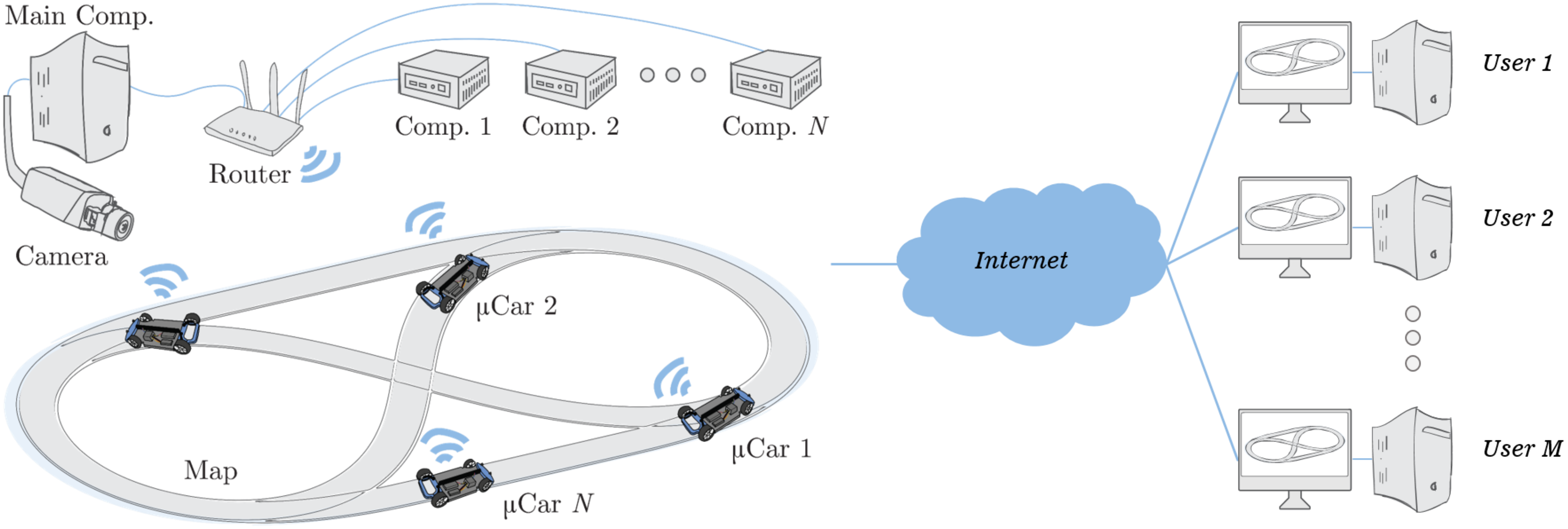
$$\dot{e}_i = \dot{e}_i$$

$$\ddot{e}_i = a_{i-1} - a_i$$

$$\dot{a}_i = -{}^{1}\!/_{T} \cdot a_i + {}^{k}\!/_{T} \cdot a_{i_{\text{ref}}}$$

Next Part

Lab work



Main Comp.
Router
Comp. 1
Comp. 2
Comp. N
Camera
µCar 2
µCar 1
µCar N
Map
Internet
User 1
User 2
User M