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Digital Thread를 이용한 도시예측 모델링

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Outline

1. Smart City
2. Digital Twin
3. Digital Thread
4. Application Method
5. System Dynamics
6. ABM(Activity based Model)
7. Traffic Signal Control in V2X Environment using AI

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Transportation Planning Laboratory

1. Smart City

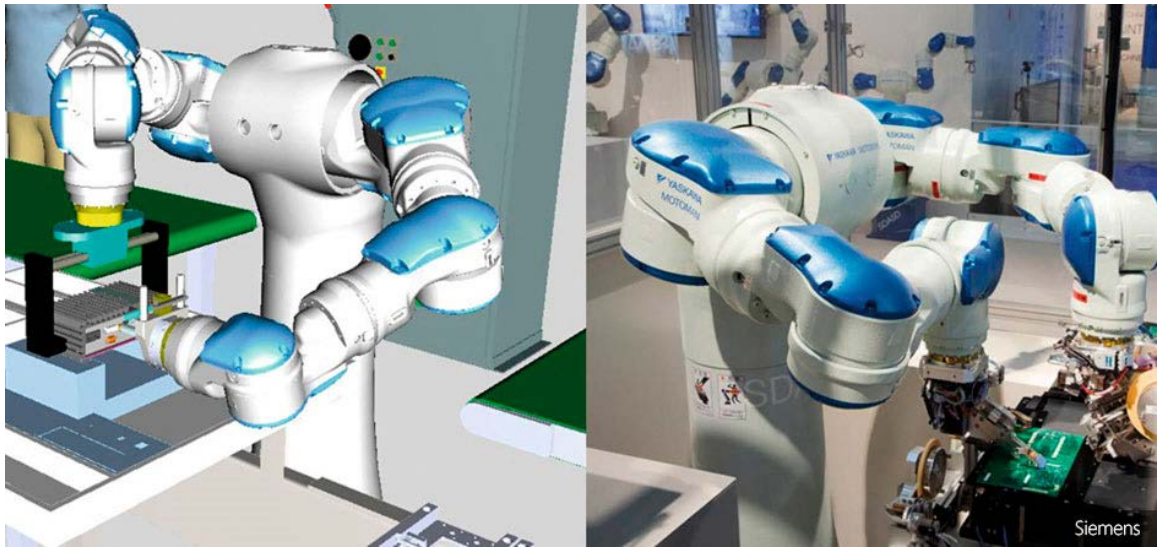
"Smart cities as a high-tech intensive and advanced city that connects people, information and city elements using new technologies in order to create a sustainable, greener city, competitive and innovative commerce, and an increased life quality (Bakıcı et al., 2012)."

"A city is smart when investments in human and social and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance (Caragliu et al., 2011)."

"Smart Cities initiatives try to improve urban performance by using data, information and information technologies (IT) to provide more efficient services to citizens, to monitor and optimize existing infrastructure, to increase collaboration among the different economic actors, and to encourage innovative business models in both the private and public sectors (Marsal-Llacuna et al., 2014)."

2. Digital Twin

- CPS(Cyber Physical System)



https://www.hannovermesse.de/en/news/digital-twins-from-siemens-81669.xhtml
http://www.technologyrecord.com/Article/siemens-and-bridg-partner-to-develop-digital-twin-technologies-63087

2. Digital Twin

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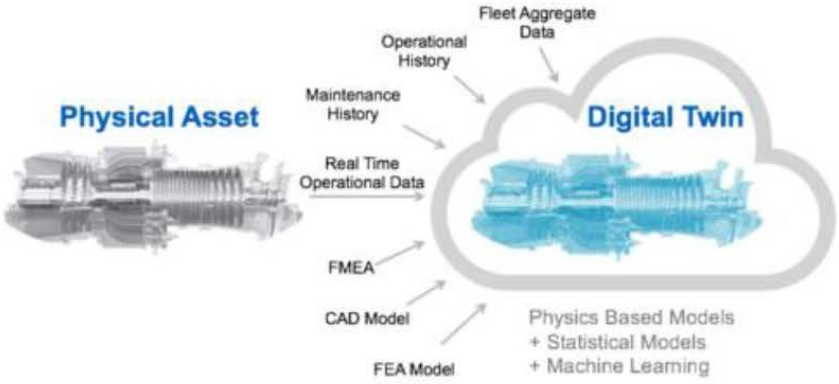
◆ 디지털 트윈(Digital Twin) 기술이란?

- 물리적 세계(Physical world)와 디지털 세계(Digital world) 간의 상호작용을 기반으로 함.
- 오늘날 △자동차 설계 △생산 현장 로봇 점검 △항공기 엔진 성능 확인 등 고도의 정밀성을 요하는 기계공학 분야에서 주로 활용됨
- 이를 통해 생산 품질의 향상 및 운영비와 개발기간의 절감 등의 효과를 기대할 수 있음



<Digital Twin 개념도>

<영화에 등장하는 Digital Twin>

출처 : 디지털트윈을 이용한 스마트시티 서비스 가상화 기술 개발, 서울시립대학교 외, 2019.

2. Digital Twin

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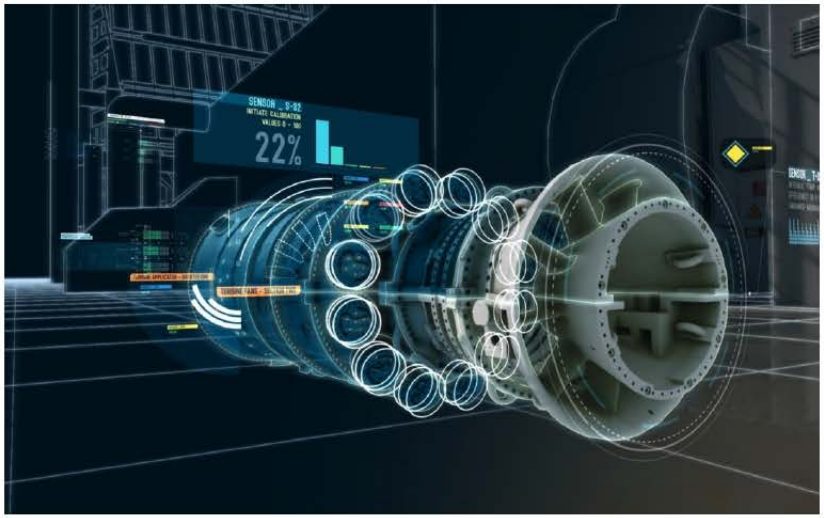
◆ 디지털 트윈의 도시 적용

- 도시화가 진행되면서 도시에 집중된 인구와 경제 활동을 둘러싸고 여러 문제 현상들이 나타나고 있음(ex: 교통정체, 주택난, 오염문제 등)
- 물리적 세계와 완벽하게 동기화 된 디지털 트윈은 이러한 도시문제들을 예측하고 관리하기에 최적의 플랫폼이라 할 수 있음
- 기계에서의 디지털 트윈과는 다르게 디지털 트윈의 도시 적용은 정밀성을 의도적으로 낮출 필요가 있음



<기계-높은 정밀도 요구>

<도시-정보의 취합/분석 능력 요구>

출처 : 디지털트윈을 이용한 스마트시티 서비스 가상화 기술 개발, 서울시립대학교 외, 2019.

2. Digital Twin

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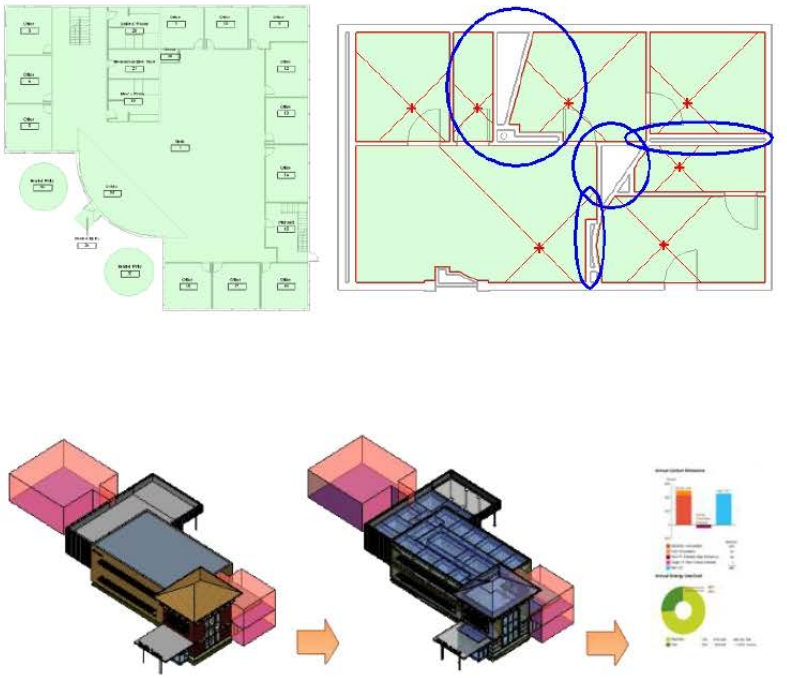
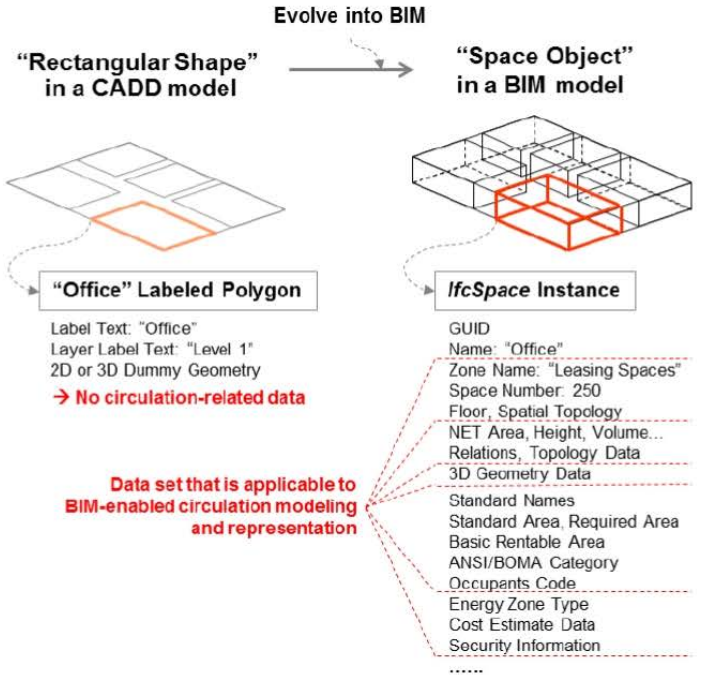
◆ BIM 에서의 공간 개념

- BIM에서의 실내공간 개념은 Room/Space 로 구분되며, 서로 다른 독립적 구성요소임
  - Room : 차지하는 지역에 대한 정보를 담는데 사용되는 건축적 구성요소
  - Space : Mechanical Electrical and Plumbing(MEP)에서 volume 분석을 위해 사용되는 요소

Room and Spaces



Space object and properties



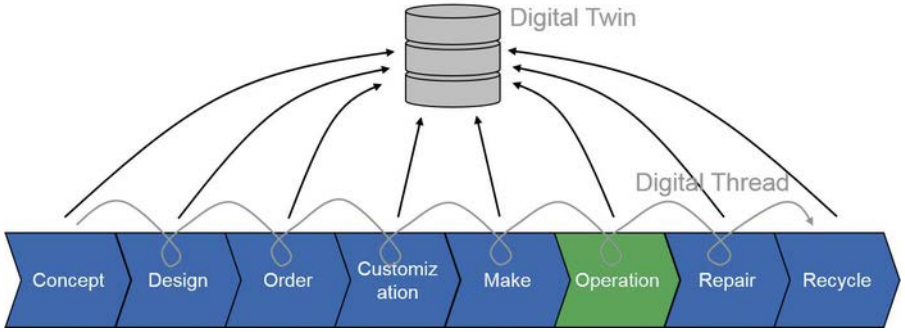
주로 개별 시설물의 실내 정보를 담는 공간으로서 객체로 정의함

출처 : 디지털트윈을 이용한 스마트시티 서비스 가상화 기술 개발, 서울시립대학교 외, 2019.

3. Digital Thread

다양한 Digital Thread에 대한 정의 존재!

제품수명주기 측면



http://www.plm.or.kr/plm/2008/info/news

CPS 측면

https://www.coursera.org/lecture/digital-thread-components/digital-thread-CM0Fd

제조업 측면

https://blogs.oracle.com/scm/your-innovation-platform-for-the-digital-thread

Digital Manufacturing

실시간성 양방향성

Digital Thread

3. Digital Thread

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도시모델링 분야의 Digital Thread

⇒ **도시의 다양한 Data를 수집 · 분석하여 실시간으로 도시예측 Modeling!**

http://www.consumerpost.co.kr/news/articleView.html?idxno=135344

https://m.blog.naver.com

http://www.dtoday.co.kr/news/articleView.html?idxno=262629

대구광역시 전경

4. Application Method

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Colorful DAEGU

기상
- ▶ 폭염발생
- ▶ 열섬확산

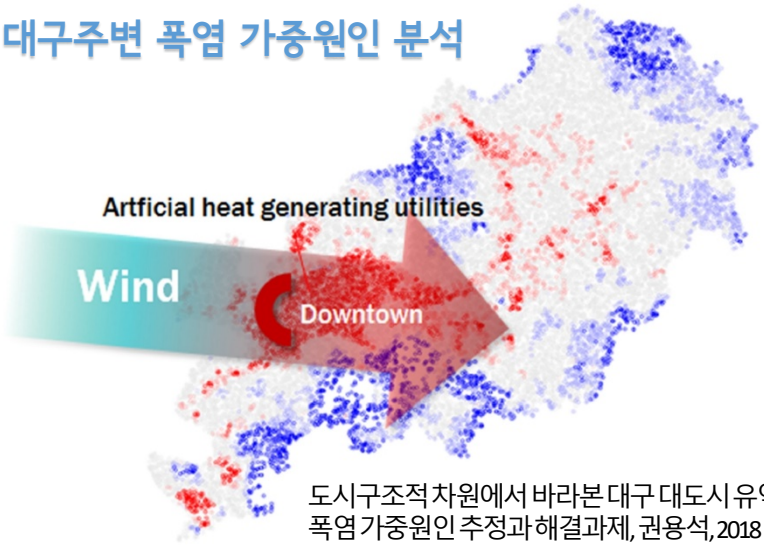
환경
- ▶ 미세먼지

에너지
- ▶ 건축물 전기사용량

교통
- ▶ 대중교통
- ▶ MaaS
- ▶ DRT

2세부 연계

대구주변 폭염 가중원인 분석



도시구조적 차원에서 바라본 대구 대도시 유역의 폭염 가중원인 추정과 해결과제, 권용석, 2018

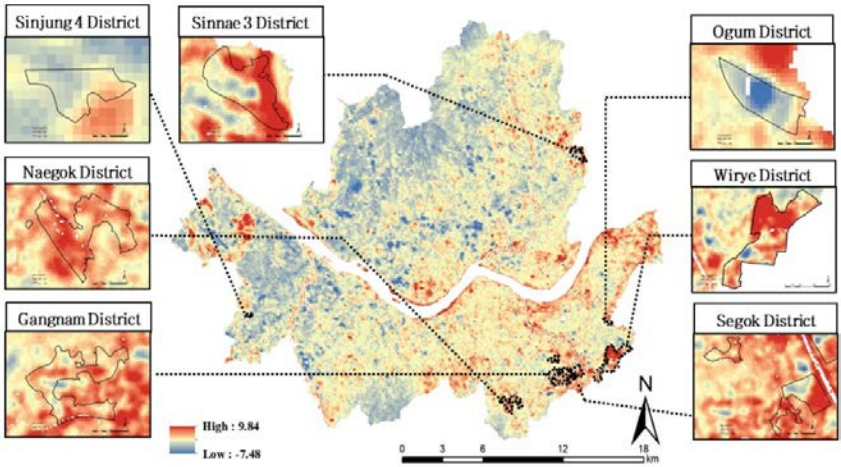
SIHEUNG CITY 시흥시

환경
- ▶ 악취
- ▶ 미세먼지

에너지
- ▶ 건축물 전기사용량

3세부 연계

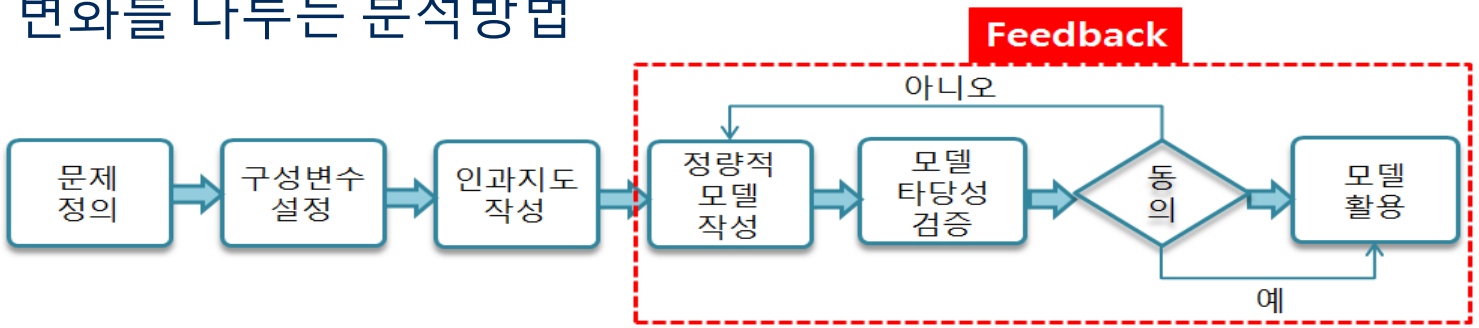
폭염 및 열대야 발생지역 예측



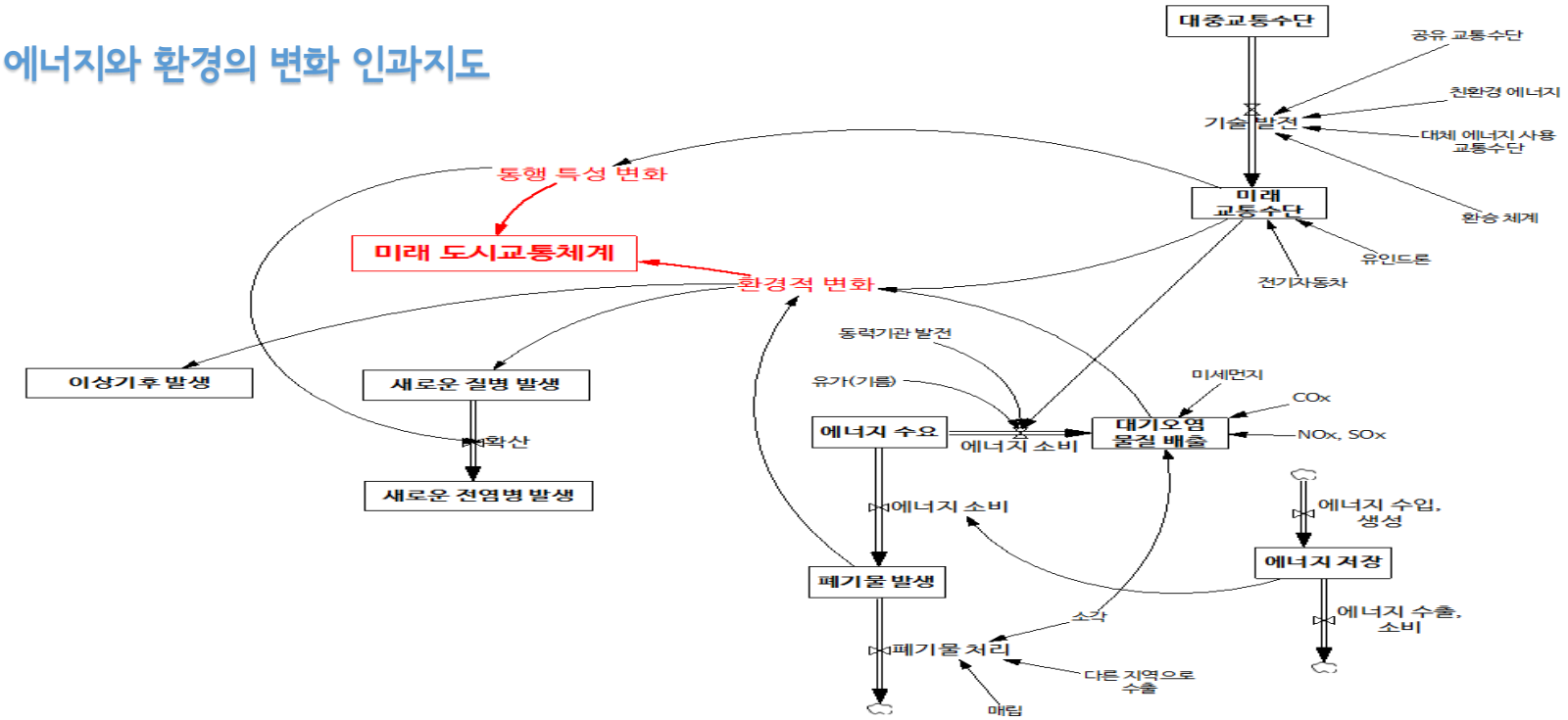
서울시 공공택지개발 사업지구에서의 지표면 온도변화 분석, 김지영 외, 2018

5. System Dynamics

동태적인 행태 변화(dynamic behavior), 즉 시간의 경과에 따른 시스템의 행태 변화를 다루는 분석방법

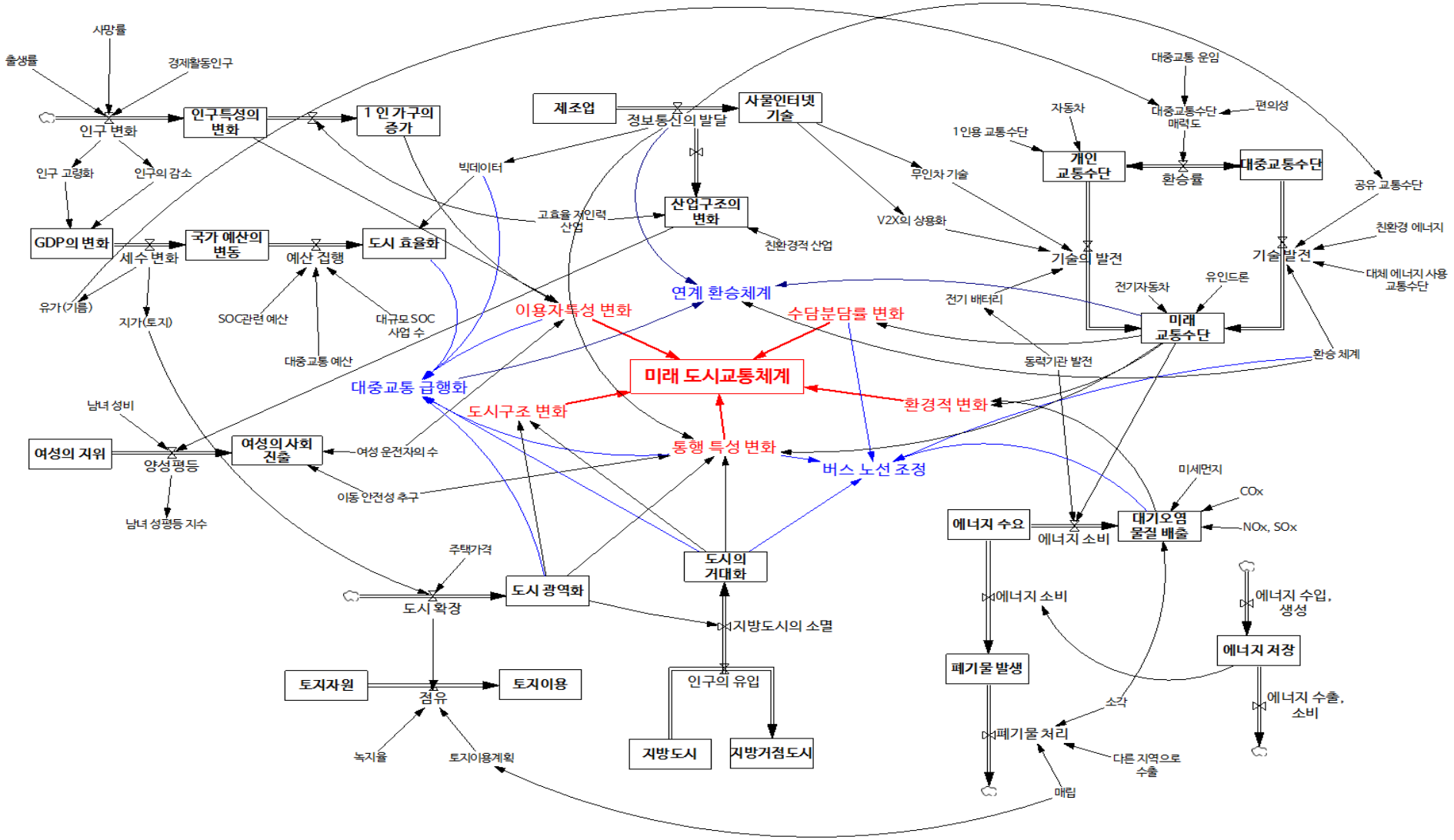


에너지와 환경의 변화 인과지도



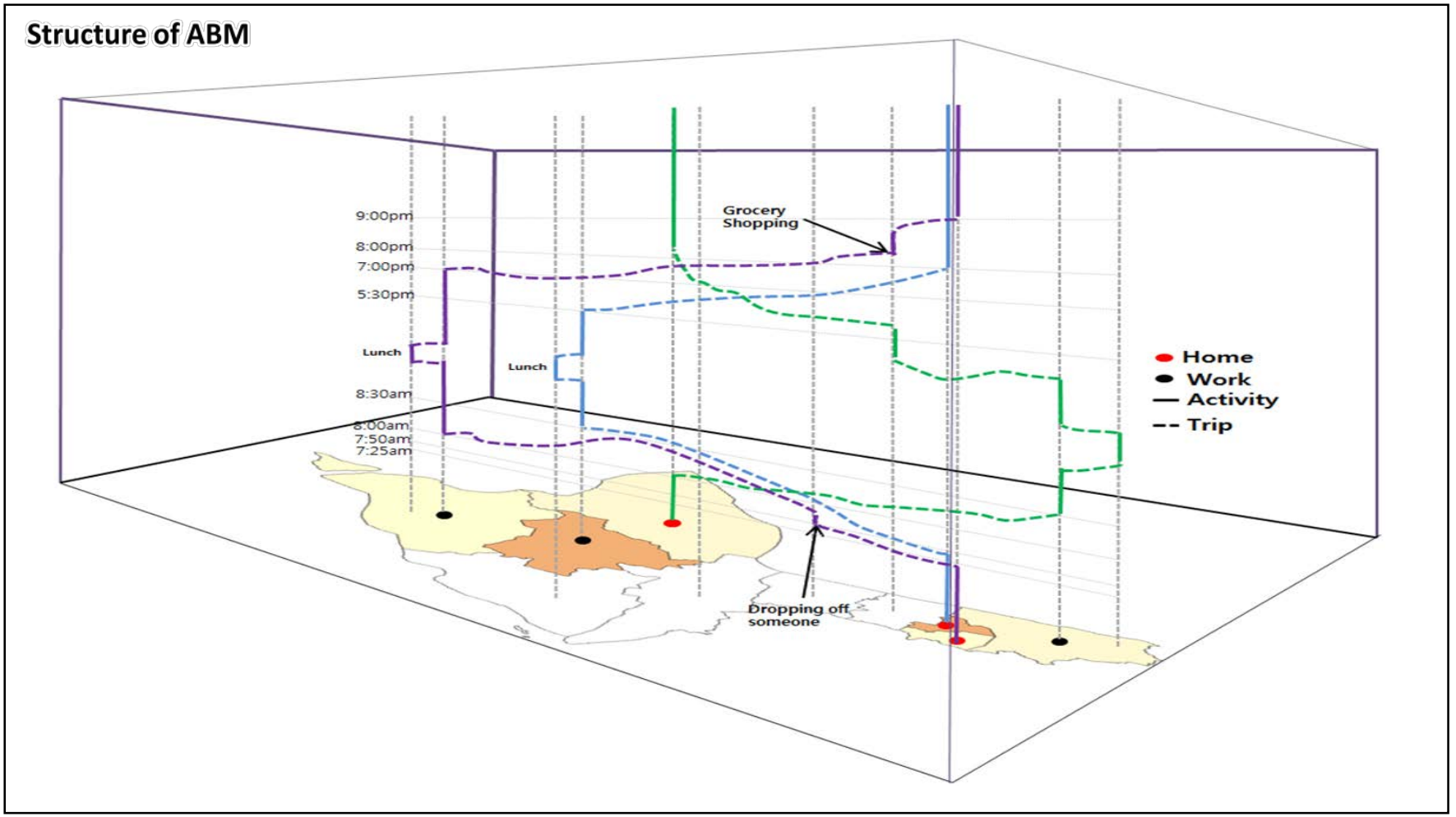
5. System Dynamics

미래 환경변화에 따른 도시교통 인과지도



6. ABM(Activity based Model)

Space Time Trajectories of Daily Activities and Movements



6. ABM(Activity based Model)

Application of MATSim Simulation Program

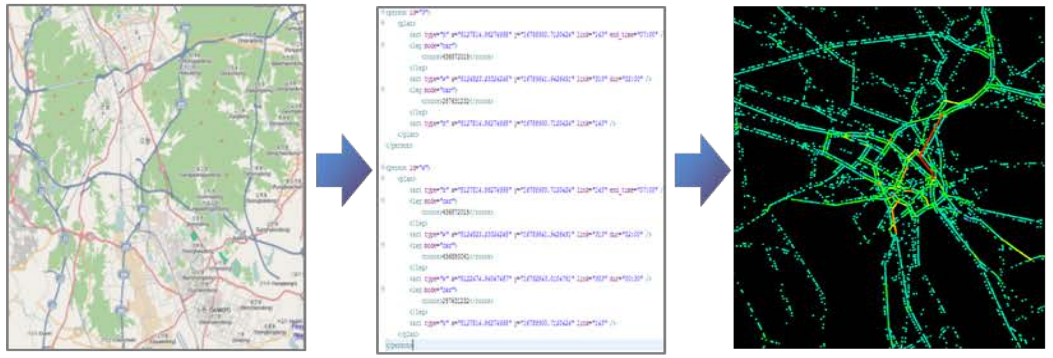
- MATSim was selected (Analyzing the Urban activity-based model and an opportunity to the national application and establish the simulation network)

Understanding the MATSim operation mechanism

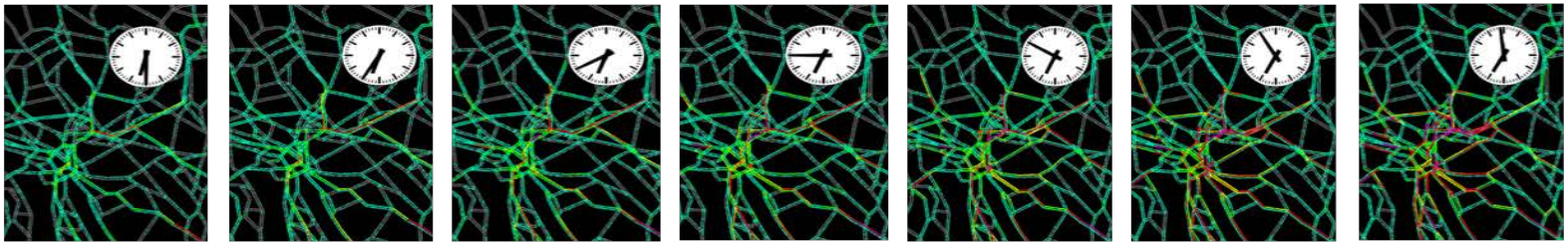
< MATSim Proceeding >

STEP 1	Coordinate extraction
	Open street map
STEP 2	Create Network
	Input location and property
STEP 3	Create Plan
	Input individual users' characteristics
STEP 4	Specify Configuration
	NETWORK, PLAN and other variables
STEP 5	Output Extract

< Create Network and Plan >



< Changes in Patterns according to Time>



6. ABM(Activity based Model)

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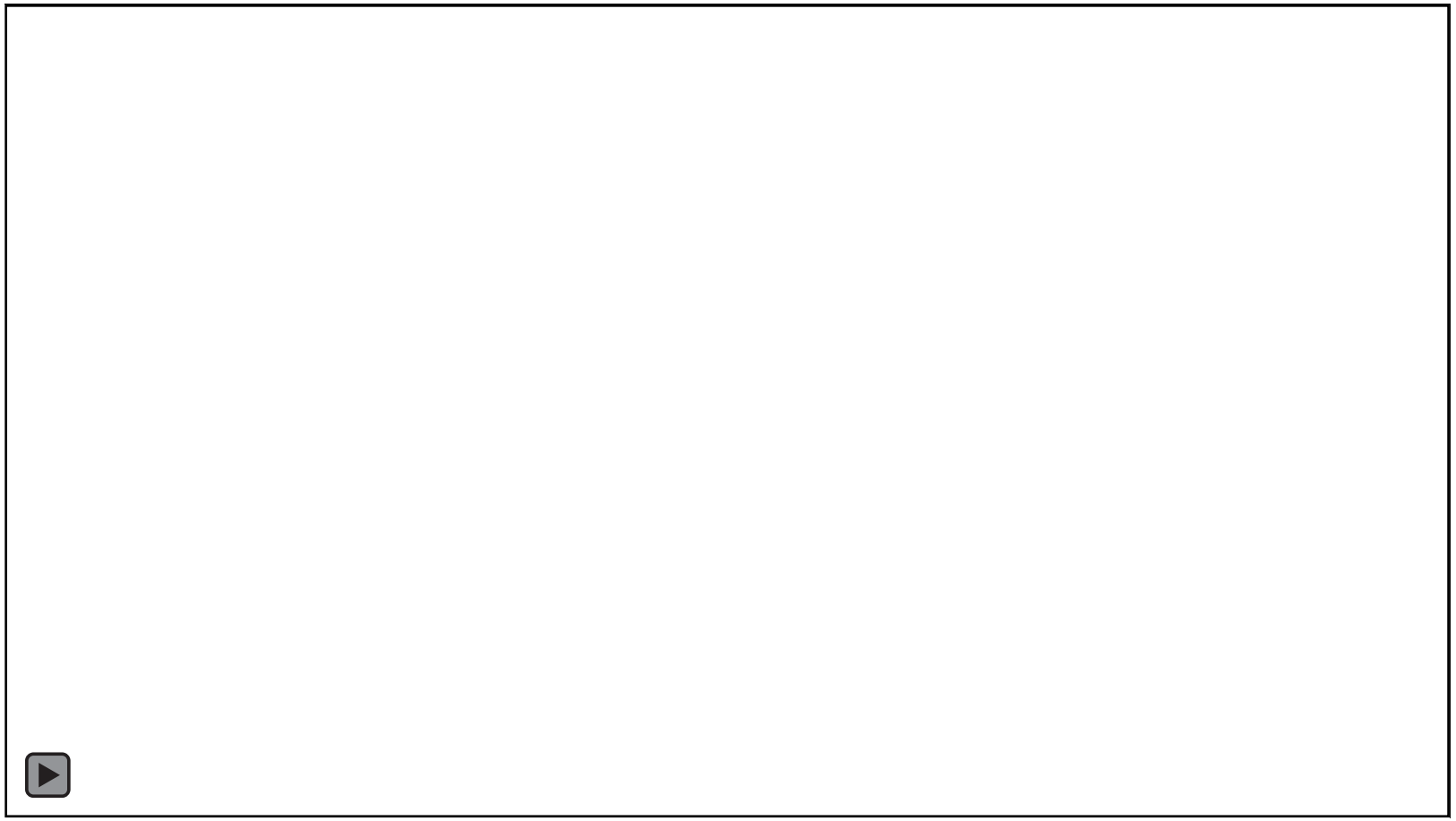
Activity based Model using Smart Card data



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Motivation

- V2X(Vehicle–To–Everything) is the core technology of CAV(Connected & Autonomous Vehicle)
- Communicating road situation in real–time by vehicle to vehicle (V2V), vehicle to infrastructure (V2I)

V2X (Vehicle–To–Everything) technology

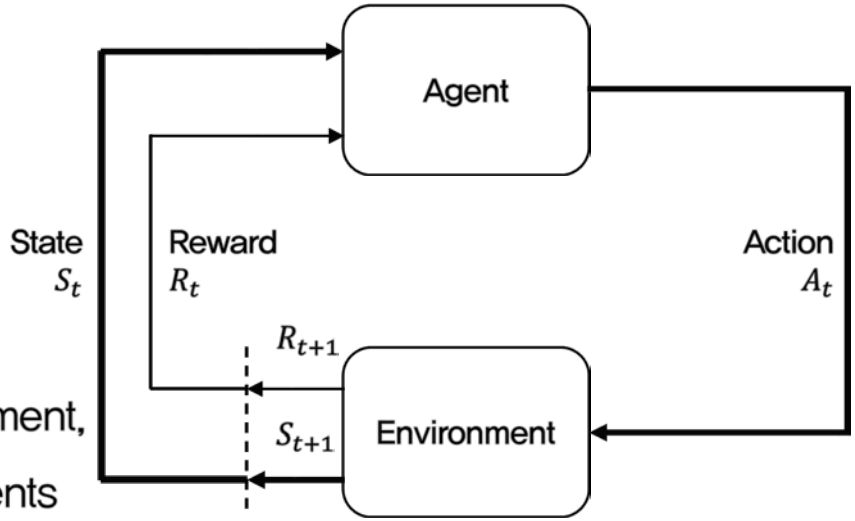
- Collecting accurate traffic information
- **Various transportation system improvement such as establishment of real–time traffic signal strategy could be possible**

Theoretical Motivation

- RL is the machine learning method for finding the optimal policy or the optimal action strategy achieving the specific objective

Reinforcement learning

- Learning by taking various actions based on the reward
- Reward corresponds to the state of the environment changing by the agent's behavior
- Does not require a model for the environment, so it can be applied in various environments

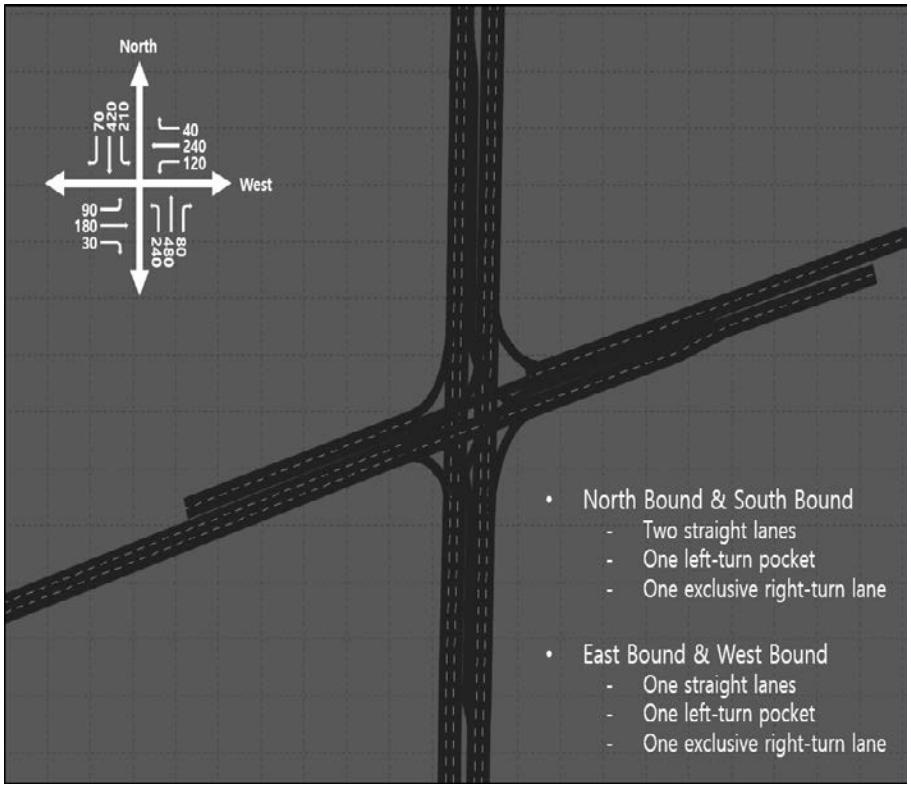


Methodology for finding the optimal traffic signal control scheme

Simulation Configuration

- The model was implemented in microscopic traffic simulator, Vissim
- Toy network was constructed and available phases to be chosen were configured

Toy network and available phases



#1 EB/WBTH	#2 EBTH/LT	#3 WBTH/LT	#4 NB/SBTH
			
#5 SBTH/LT	#6 NBTH/LT	#7 EB/WBLT	#8 NB/SBLT
			

7. Traffic Signal Control in V2X Environment using AI

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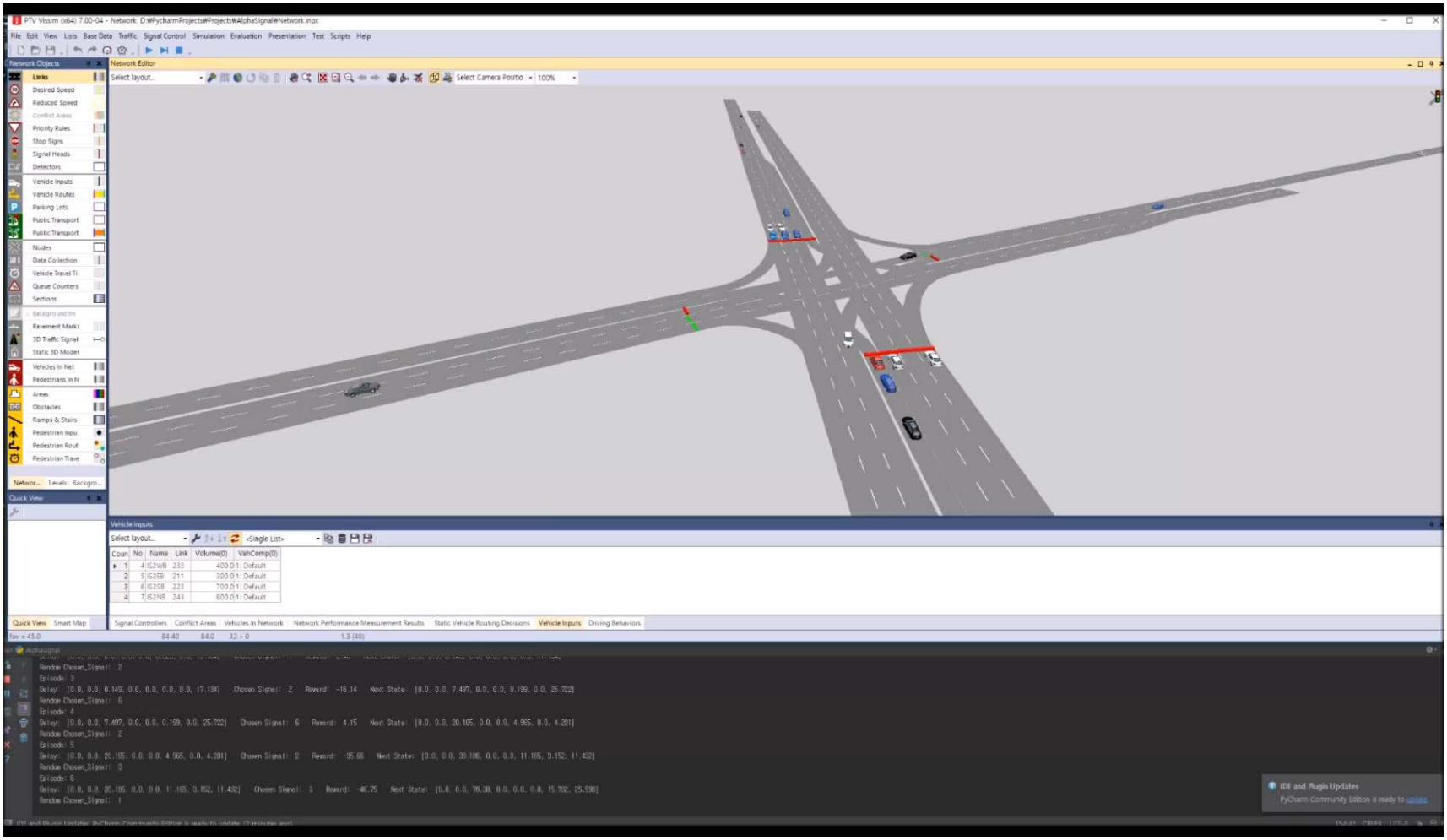
Simulation movie



7. Traffic Signal Control in V2X Environment using AI

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Evaluation results

- Proposed model, model 1 and model 2 are compared for 200 simulation time steps
- Proposed model showed decreased delay time and HC emission than model 1
- Though proposed model showed increased delay time than model 2, it showed decreased HC emission

Evaluation results of three models

	Model 4	Model 2	Model 3
Average decreased delay (sec/veh)	0.107453	0.021739	0.108585
Average decreased HC emission (mg/veh)	0.014195	−0.01743	−0.02611
Average obtained reward	20.59607	–	–

감사합니다.

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