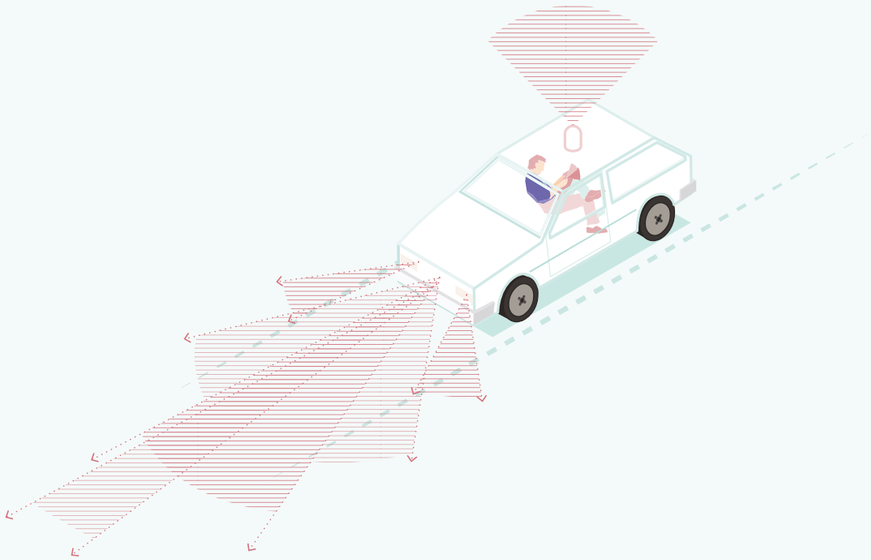
AUTOMATED DRIVING: DRIVING URBAN DEVELOPMENT?

AN INTEGRATED RESEARCH-BY-DESIGN COMPUTATIONAL MODELLING APPROACH IN URBAN PLANNING PROBLEMS



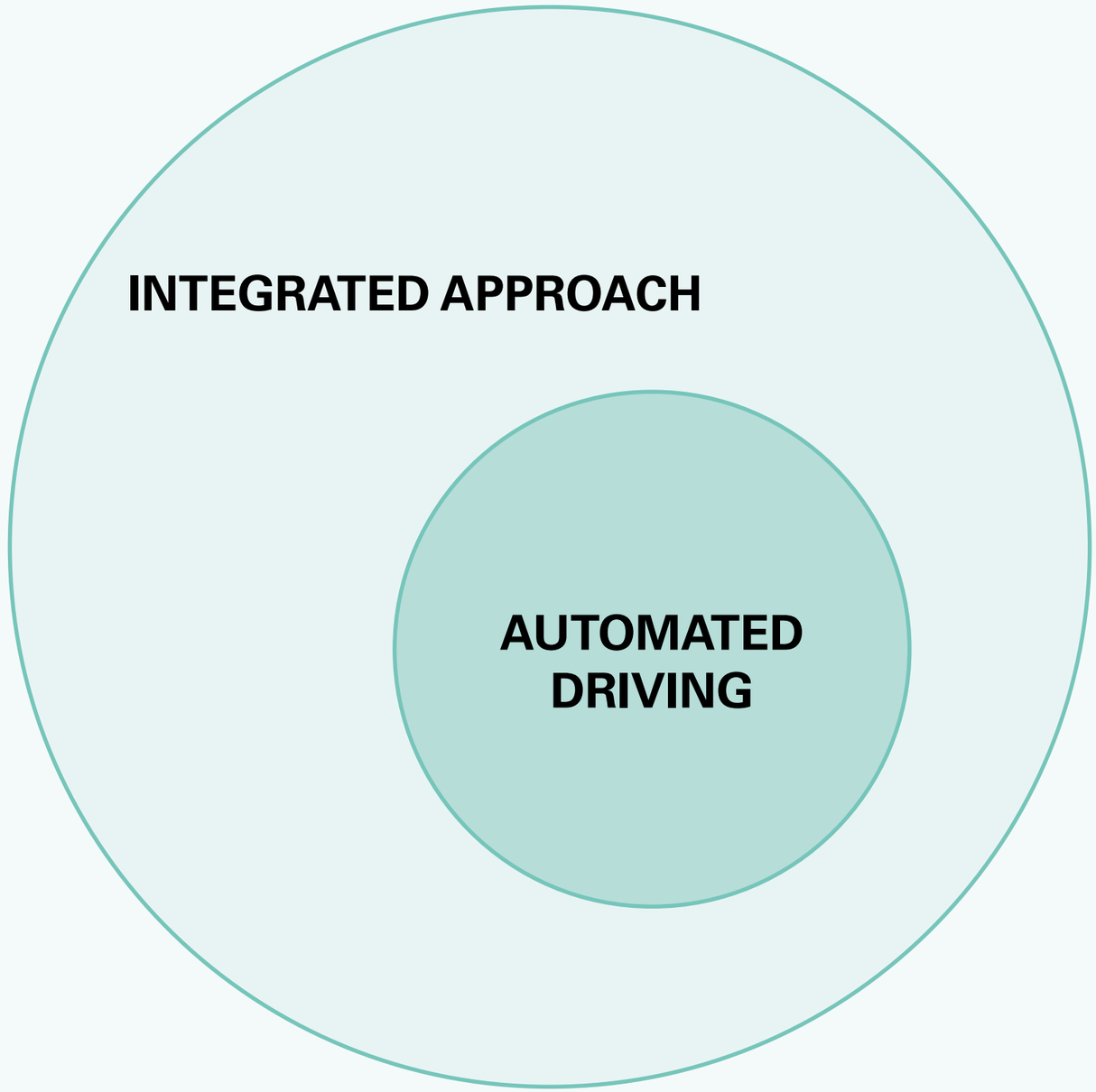
MARTIJN HOLLESTELLE
27/10/207

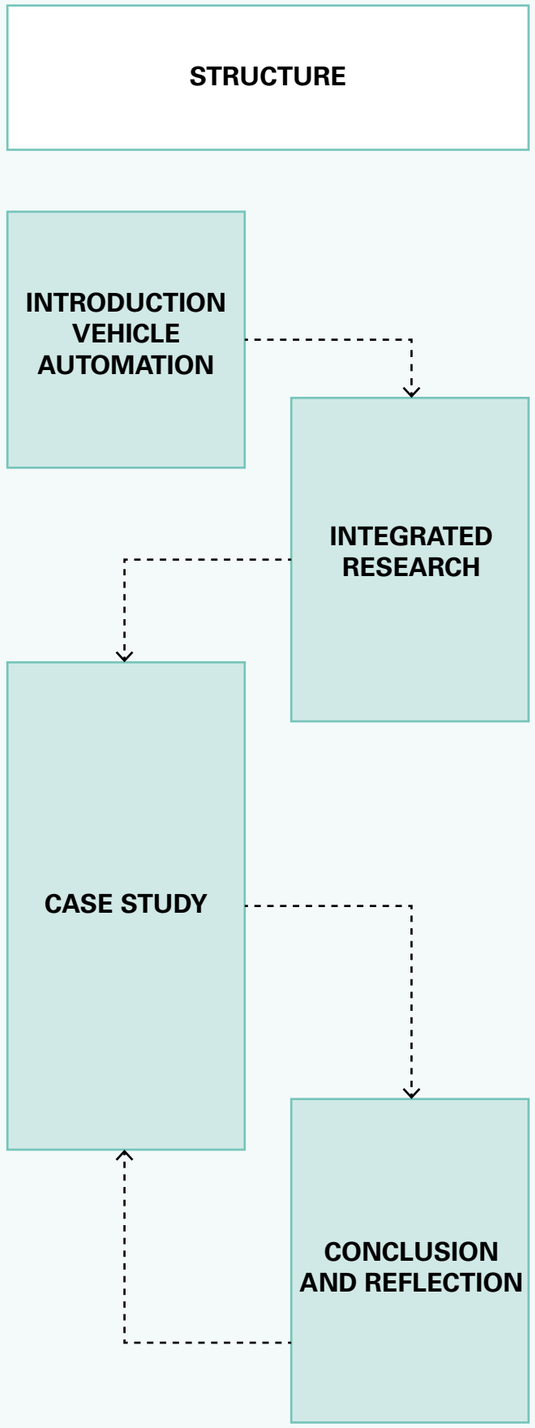
COMMITTEE:
DR. E.H. STOLK
DR. A VAN NES

P5 FINAL PRESENTATION

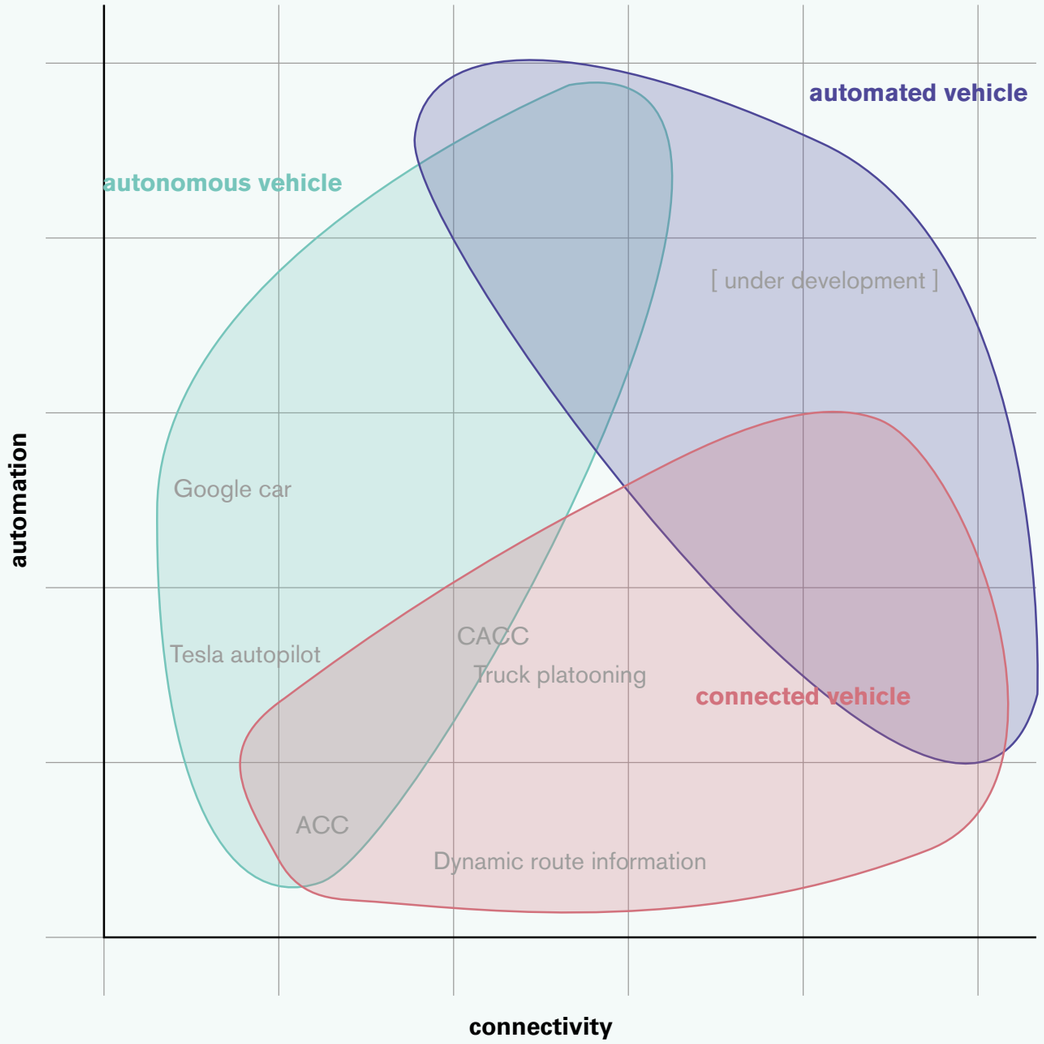
MSC ARCHITECTURE, URBANISM AND BUILDINGS SCIENCES

Image source: Busalto (2011)


INTEGRATED APPROACH
AUTOMATED DRIVING

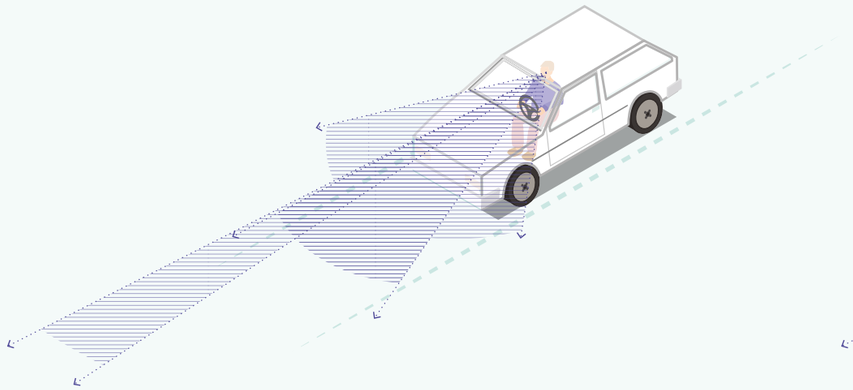

STRUCTURE
INTRODUCTION
VEHICLE
AUTOMATION
INTEGRATED
RESEARCH
CASE STUDY
CONCLUSION
AND REFLECTION

INTRODUCTION TO VEHICLE AUTOMATION

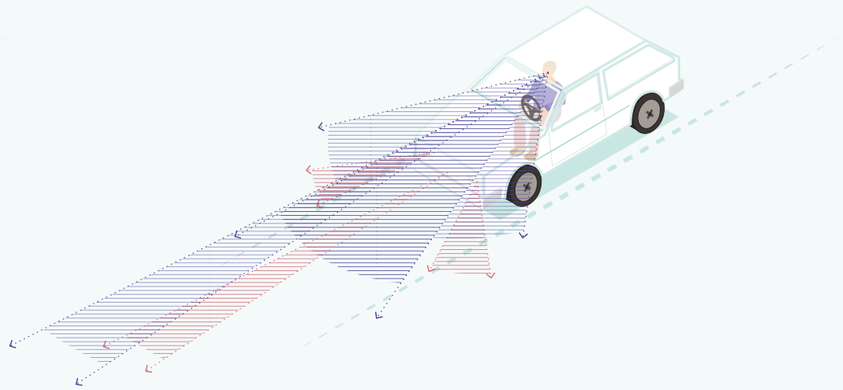


DEGREES OF AUTOMATION

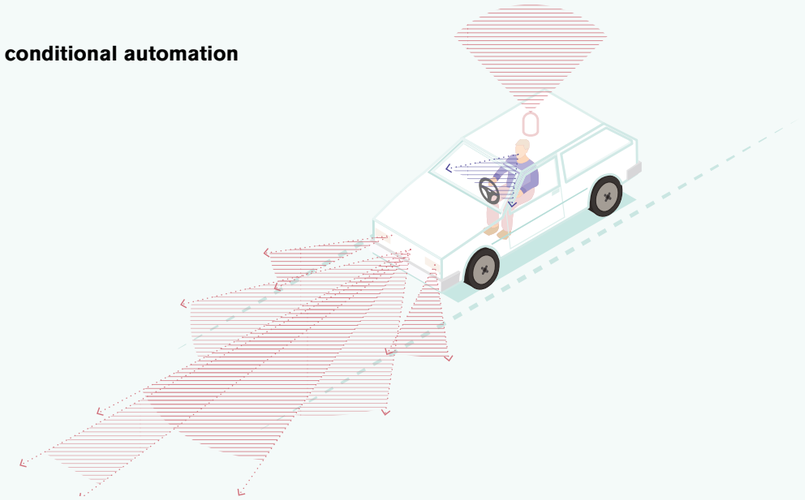
no automation



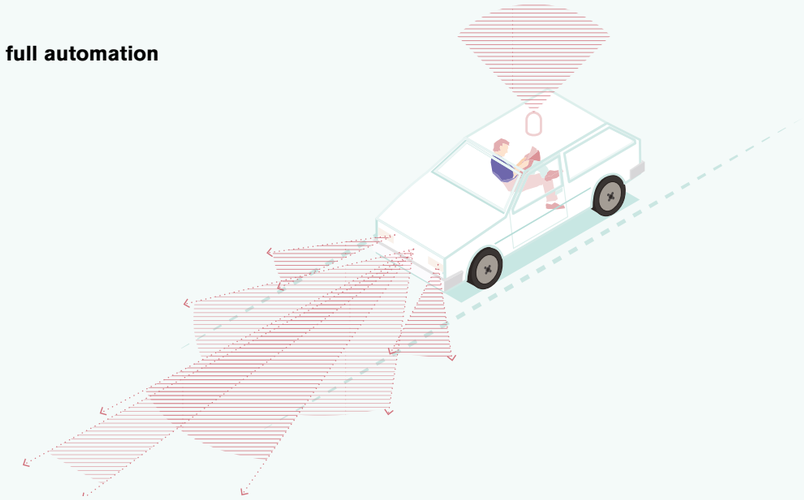
partial automation



conditional automation

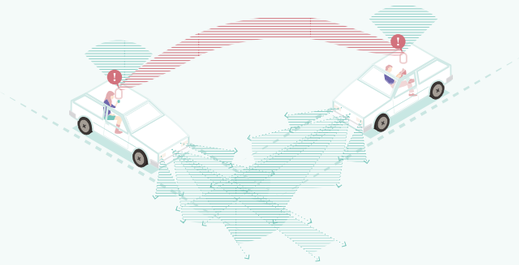


full automation

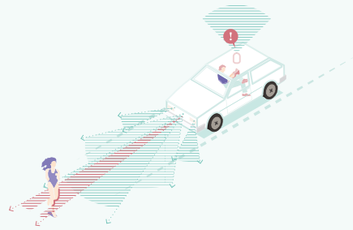


APPLICATIONS OF AUTOMATED DRIVING

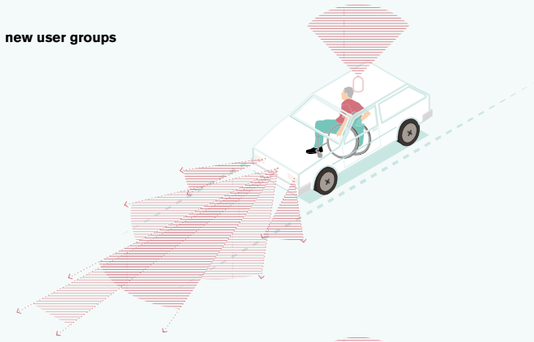
vehicle-to-vehicle (V2V)



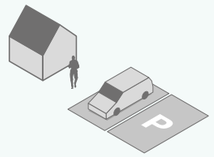
vehicle-to-other road users (V2P)



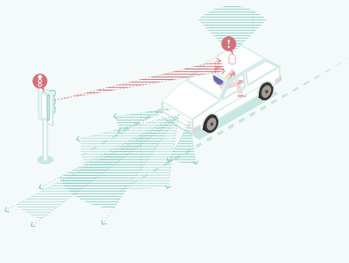
new user groups



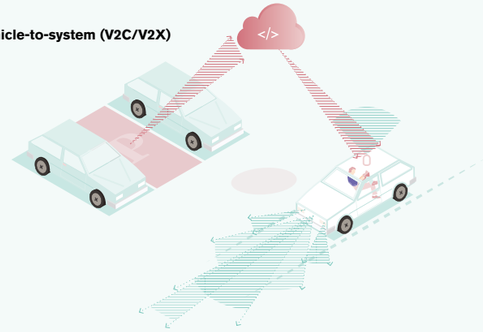
valet parking



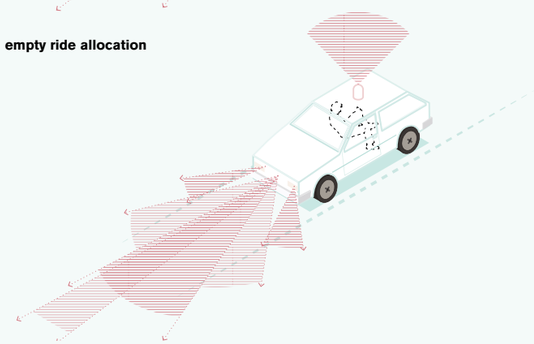
vehicle-to-infrastructure (V2I)

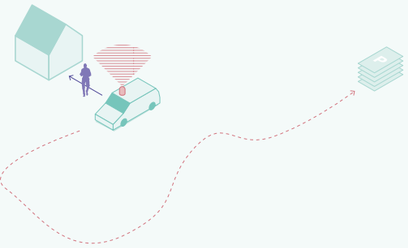


vehicle-to-system (V2C/V2X)

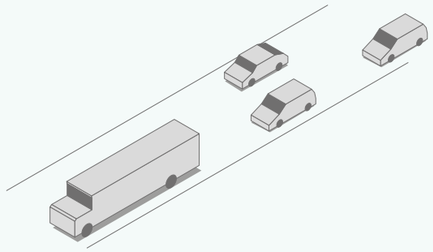


empty ride allocation

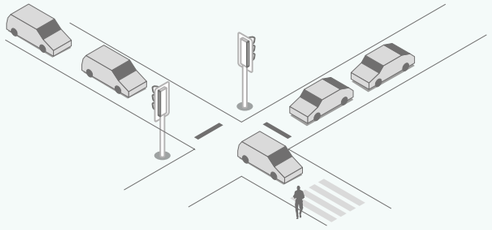




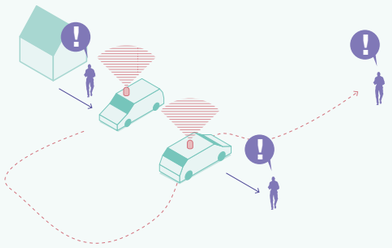
platooning



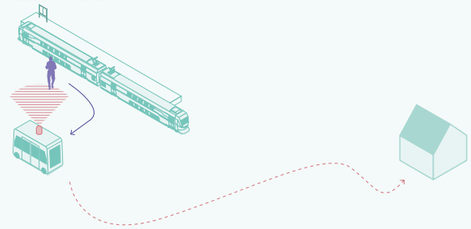
intersection management

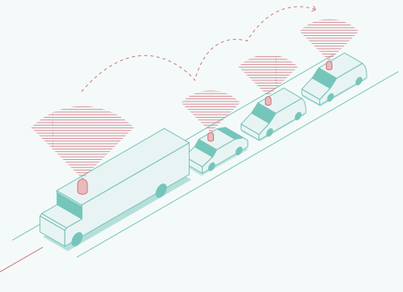


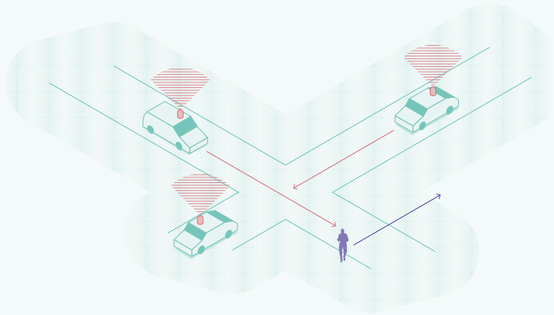
dynamic responsive transit



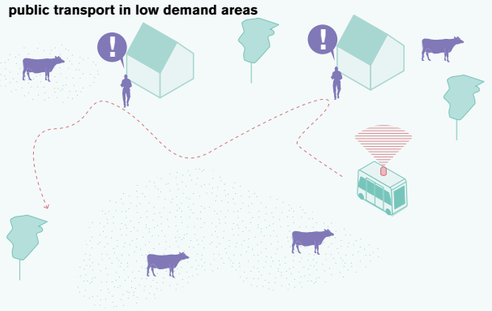
last-mile solutions



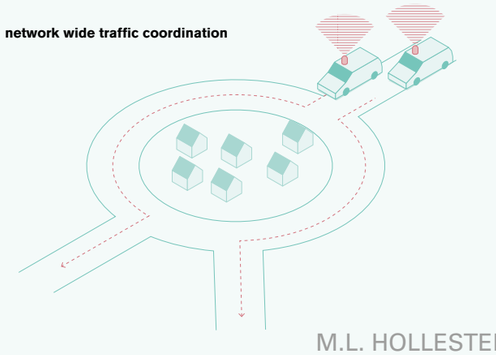


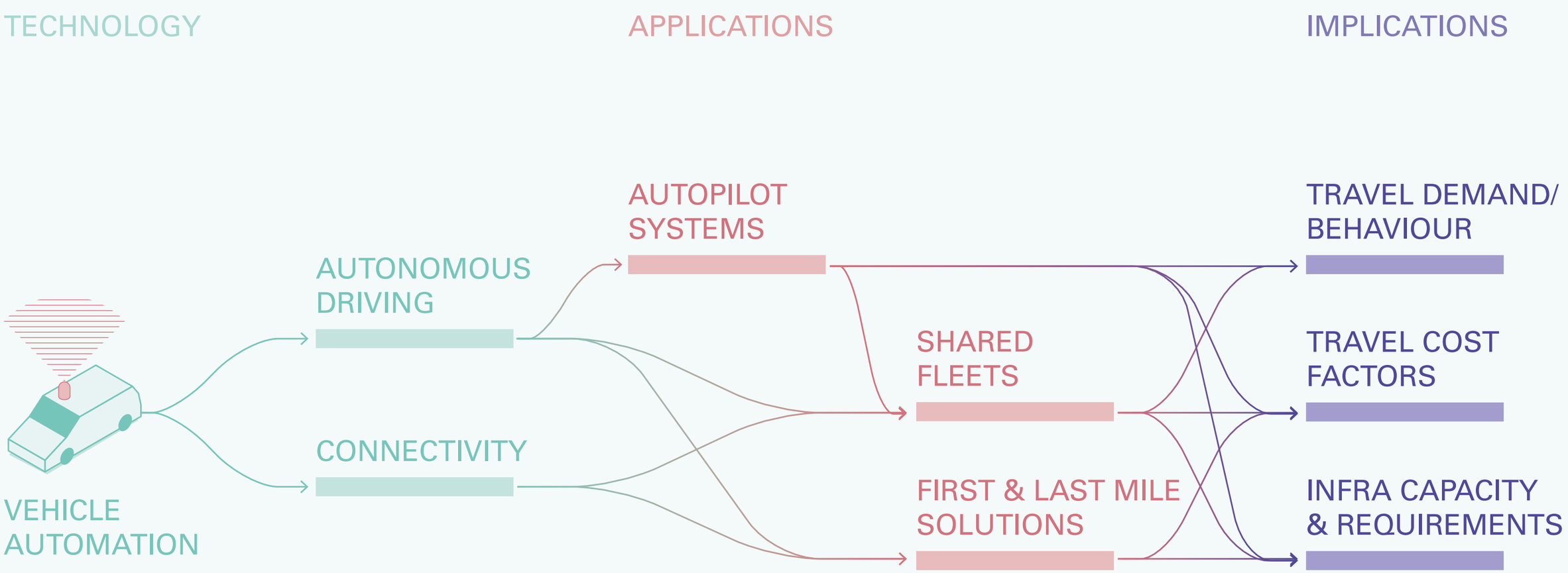


public transport in low demand areas

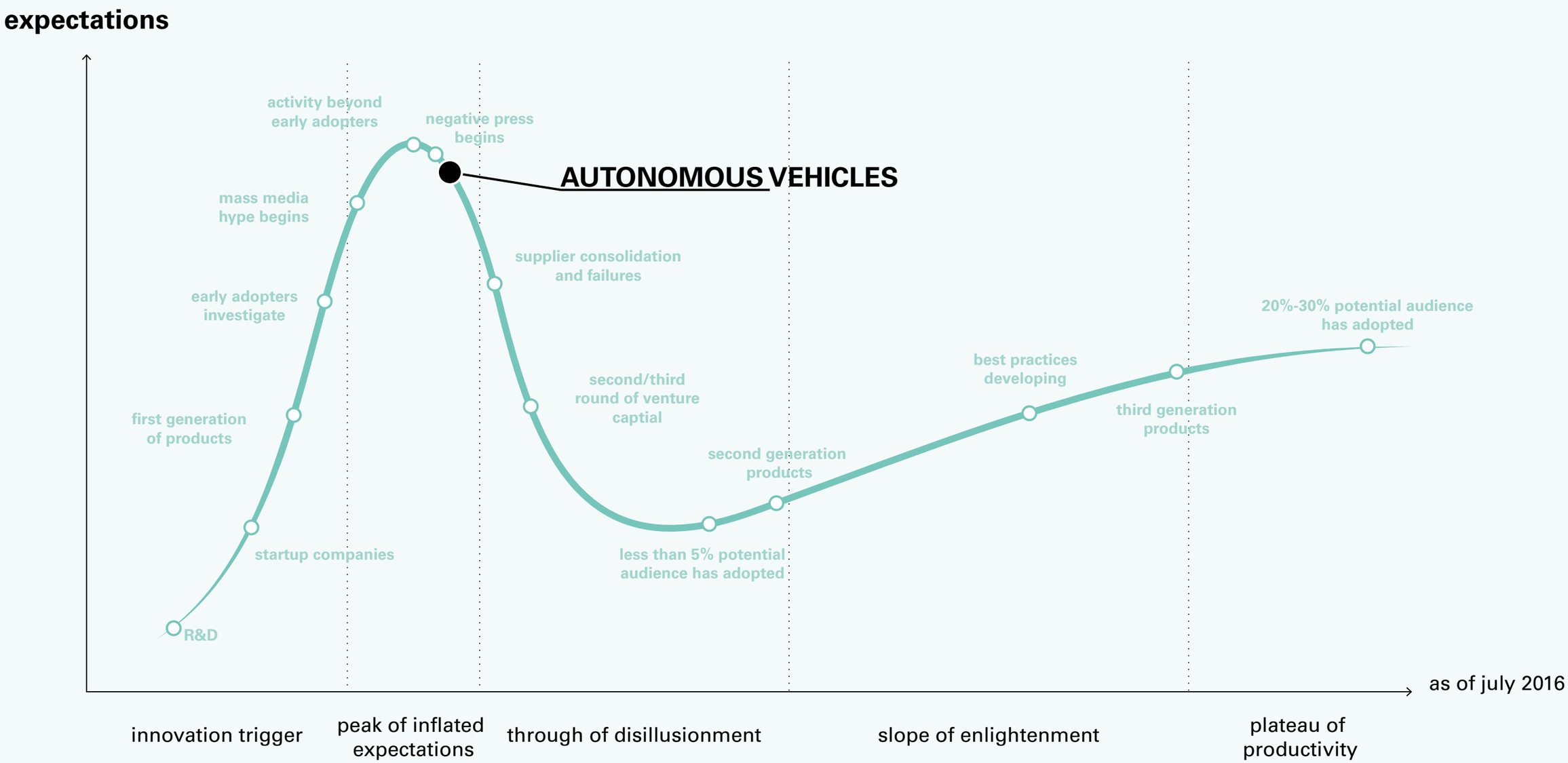


network wide traffic coordination

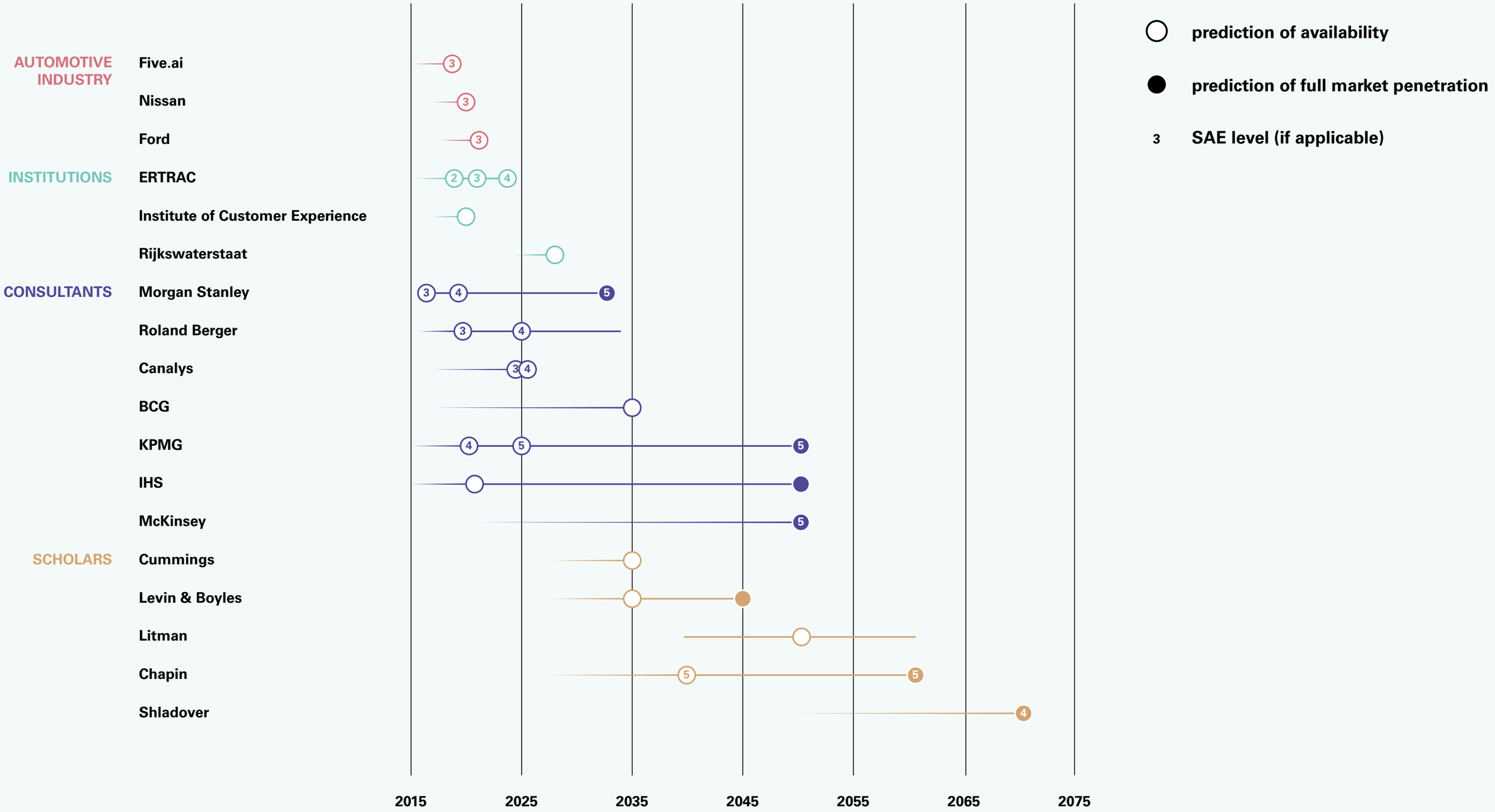



TECHNOLOGY
APPLICATIONS
IMPLICATIONS
AUTONOMOUS DRIVING
CONNECTIVITY
VEHICLE AUTOMATION
AUTOPILOT SYSTEMS
SHARED FLEETS
FIRST & LAST MILE SOLUTIONS
TRAVEL DEMAND/ BEHAVIOUR
TRAVEL COST FACTORS
INFRA CAPACITY & REQUIREMENTS

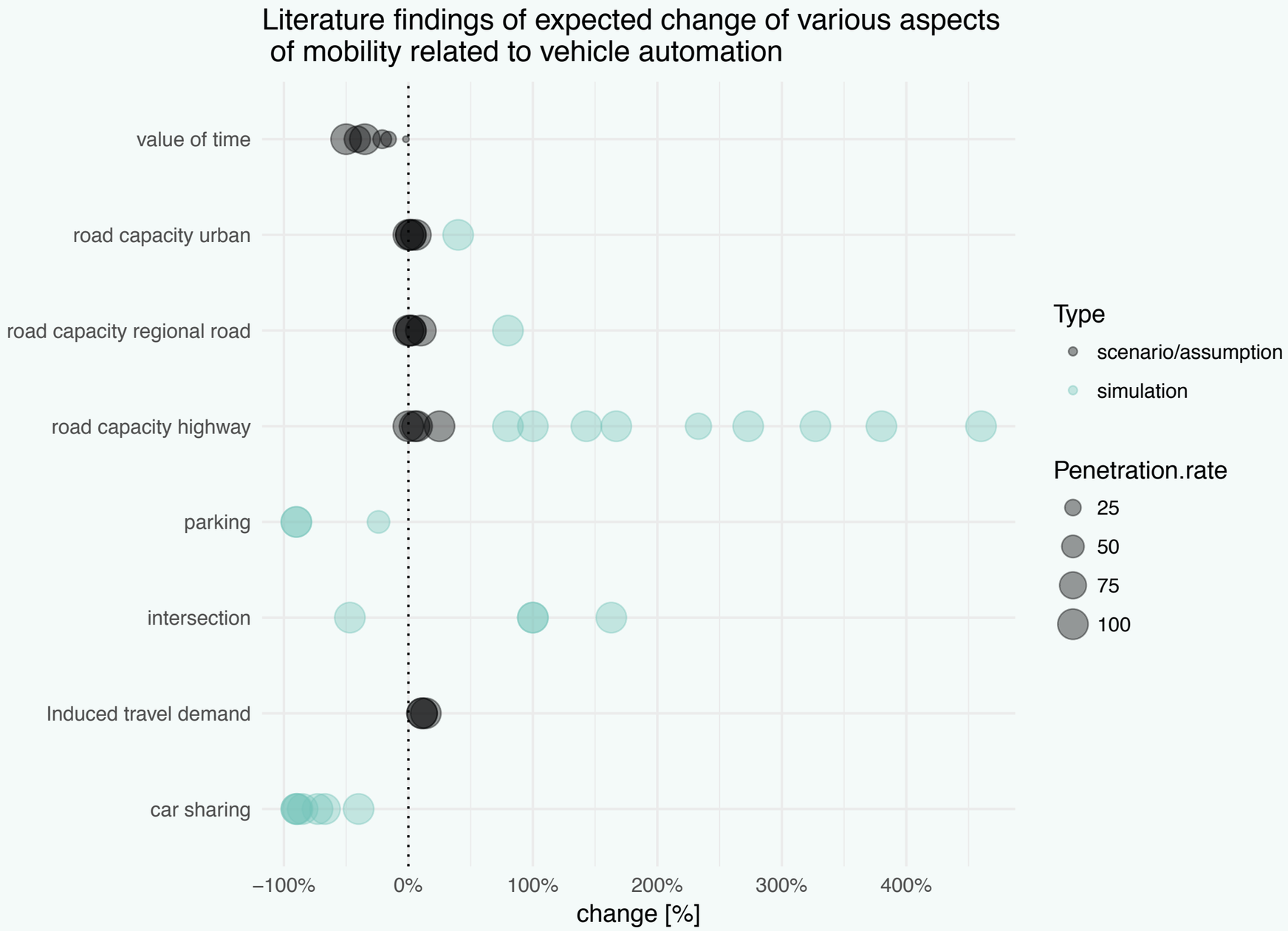
A TECHNOLOGY IN TRANSITION



A TECHNOLOGY IN TRANSITION

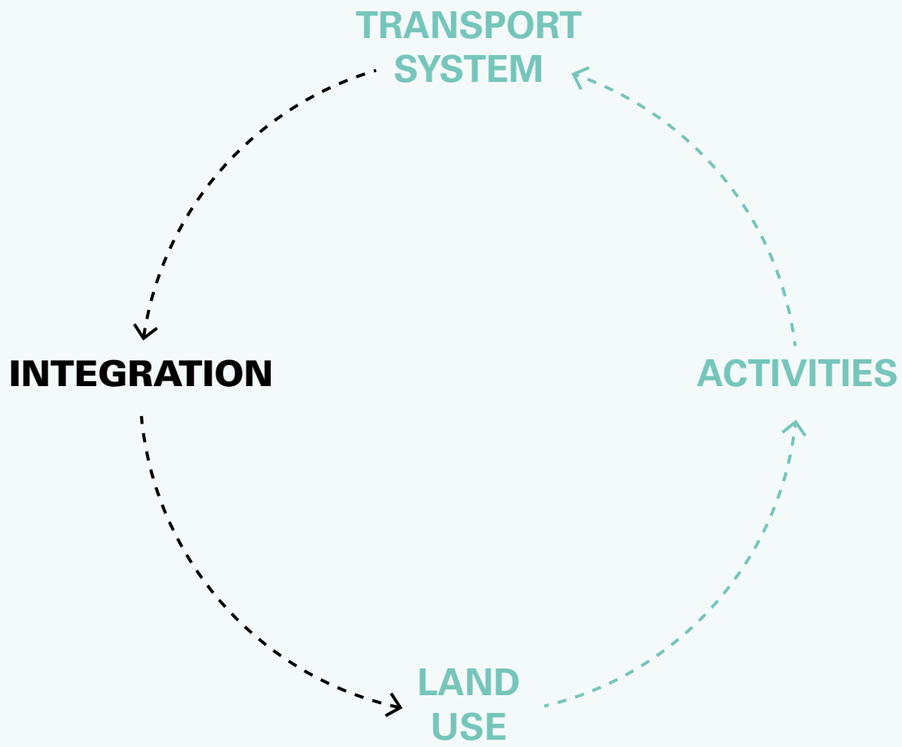


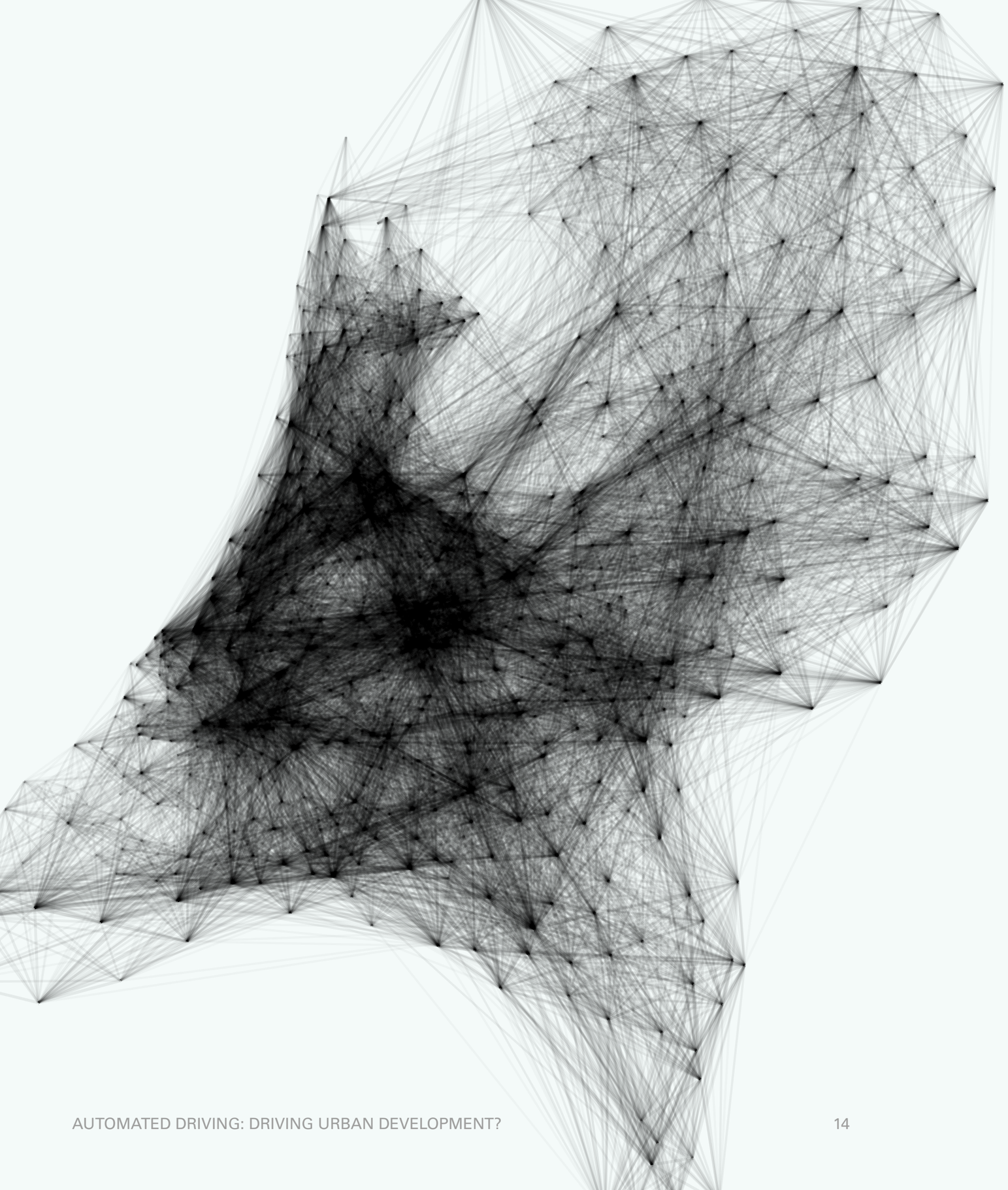
UNCERTAINTY AROUND THE IMPLICATIONS

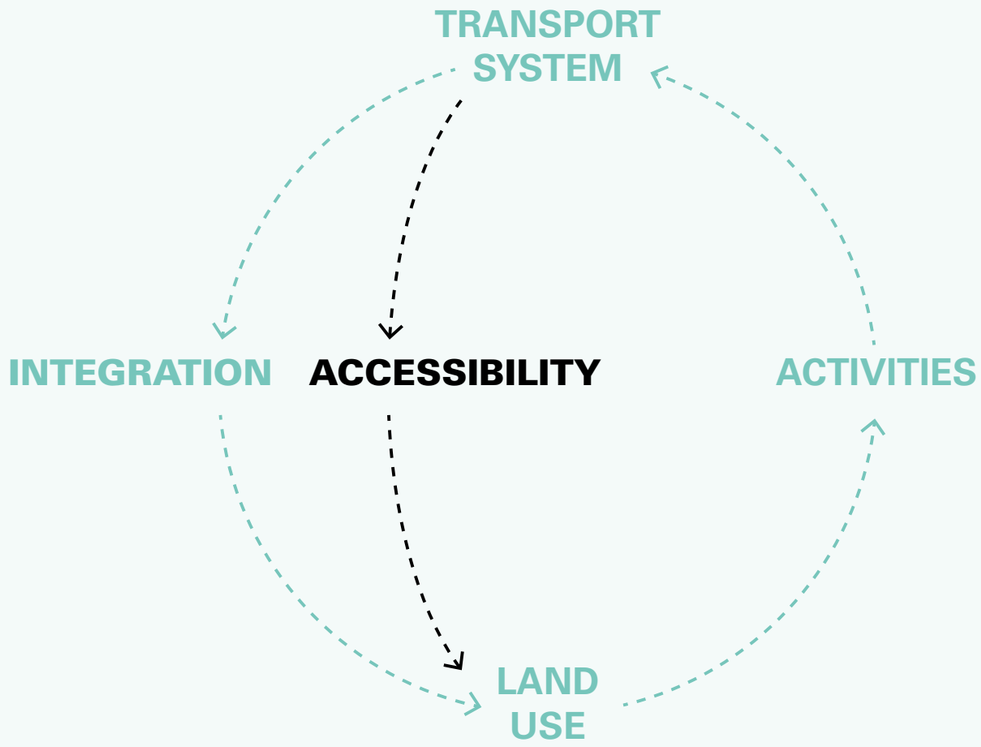


AN INTEGRATED APPROACH TO URBAN PLANNING PROBLEMS

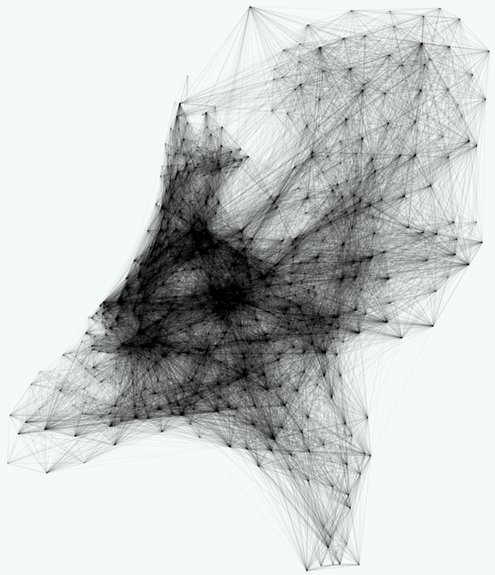
Image courtesy of BIG

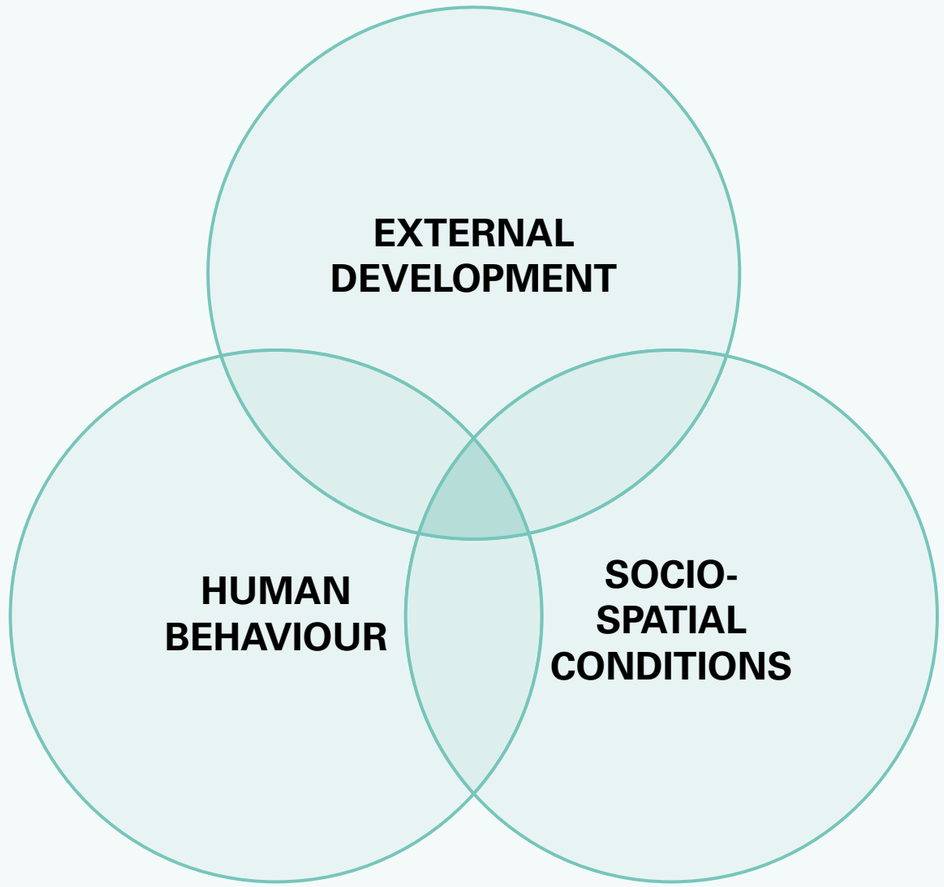

TRANSPORT SYSTEM
INTEGRATION
ACTIVITIES
LAND USE




TRANSPORT SYSTEM
INTEGRATION
ACCESSIBILITY
ACTIVITIES
LAND USE

COMPLEX URBAN PLANNING PROBLEMS





Las Vegas, photo: Michael Light

A DIFFERENT PARADIGM FOR CITIES

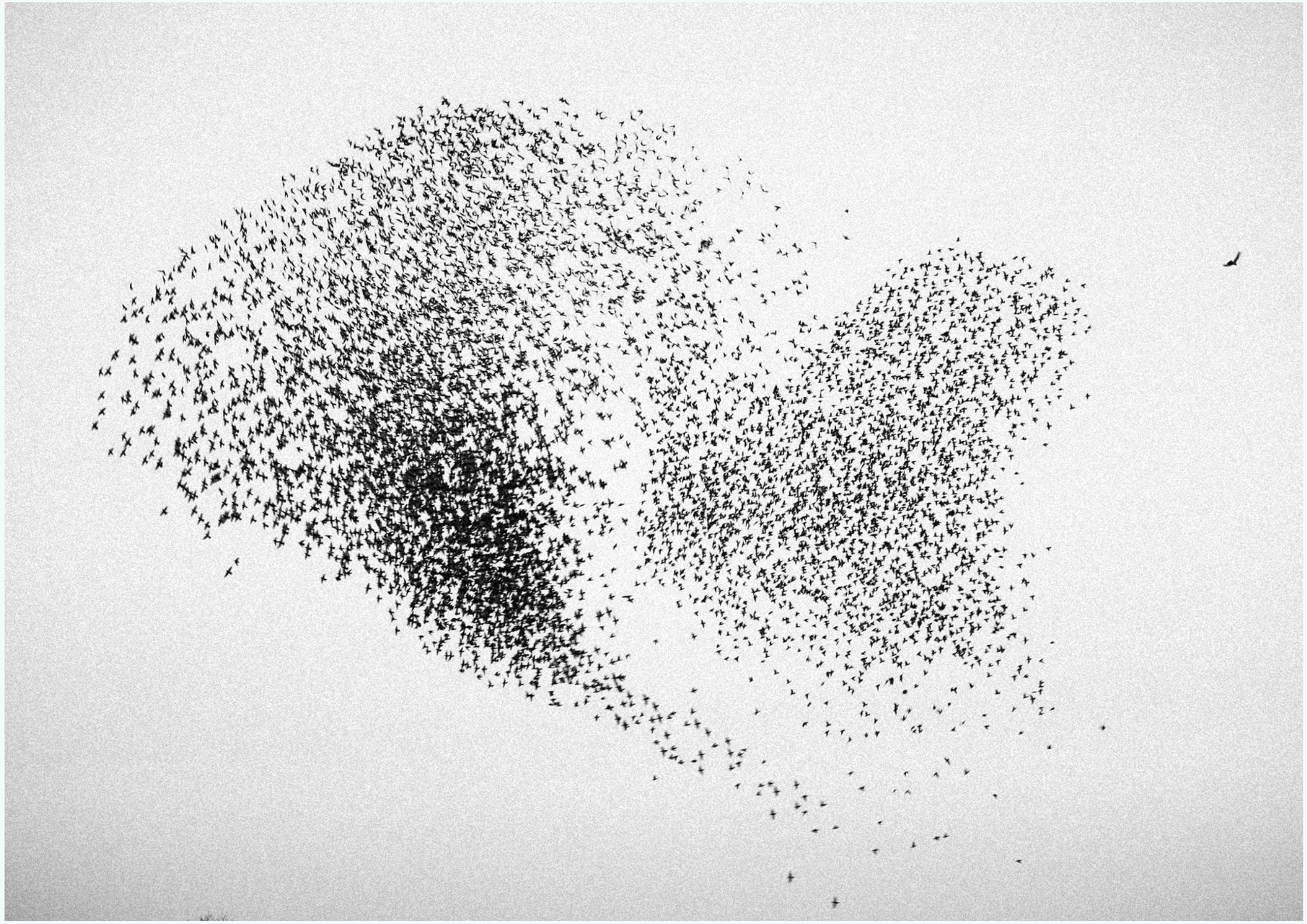


photo: Heleen Klop, constrast and colour adjusted by author

*How can an **integrated** engineering-based and design-based research lead to **better understanding of urban planning problems** and what are the consequences of an integrated approach for the **research process**?*

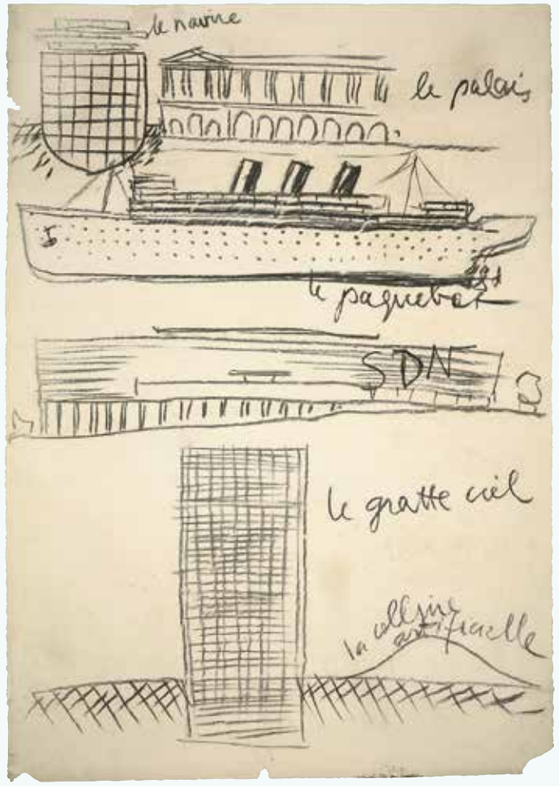


Image courtesy of Le Corbusier Foundation

Image source: Busalto (2011)

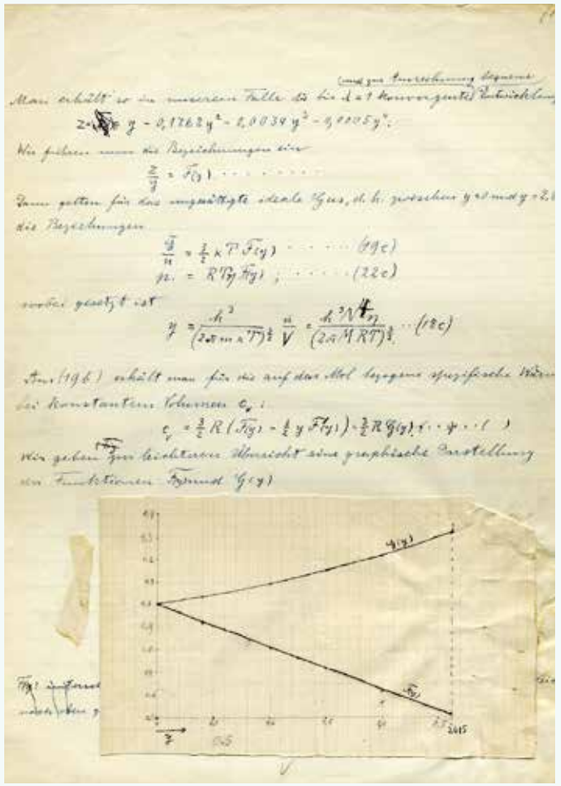
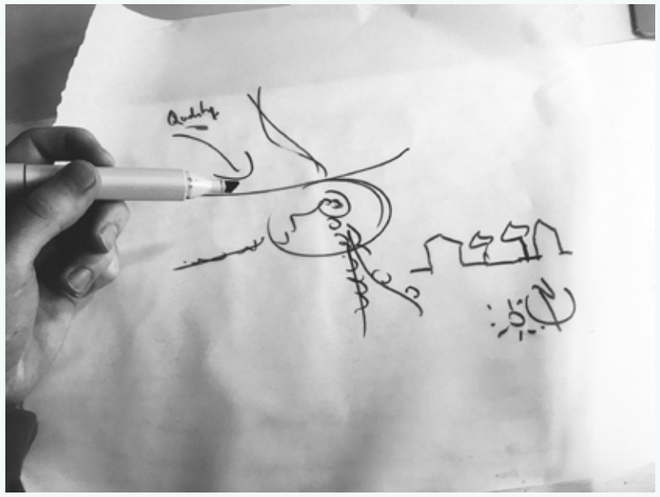
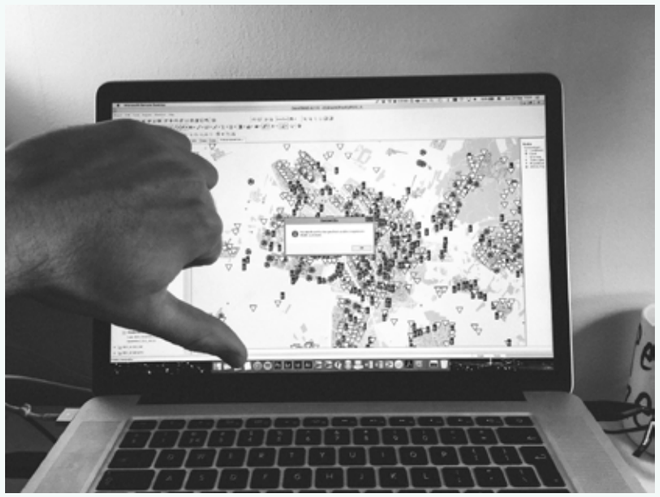
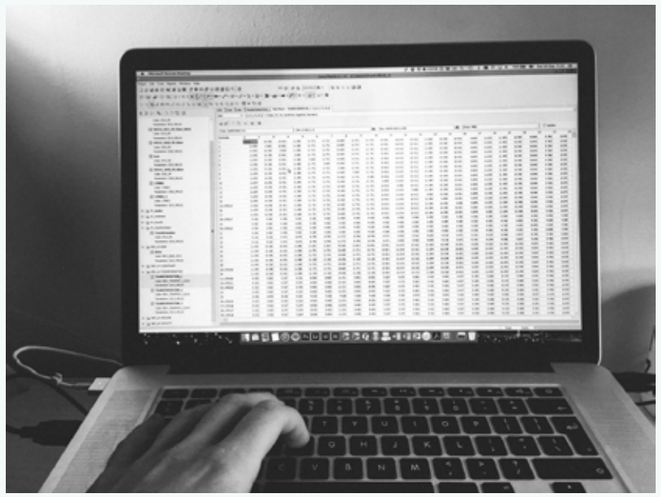


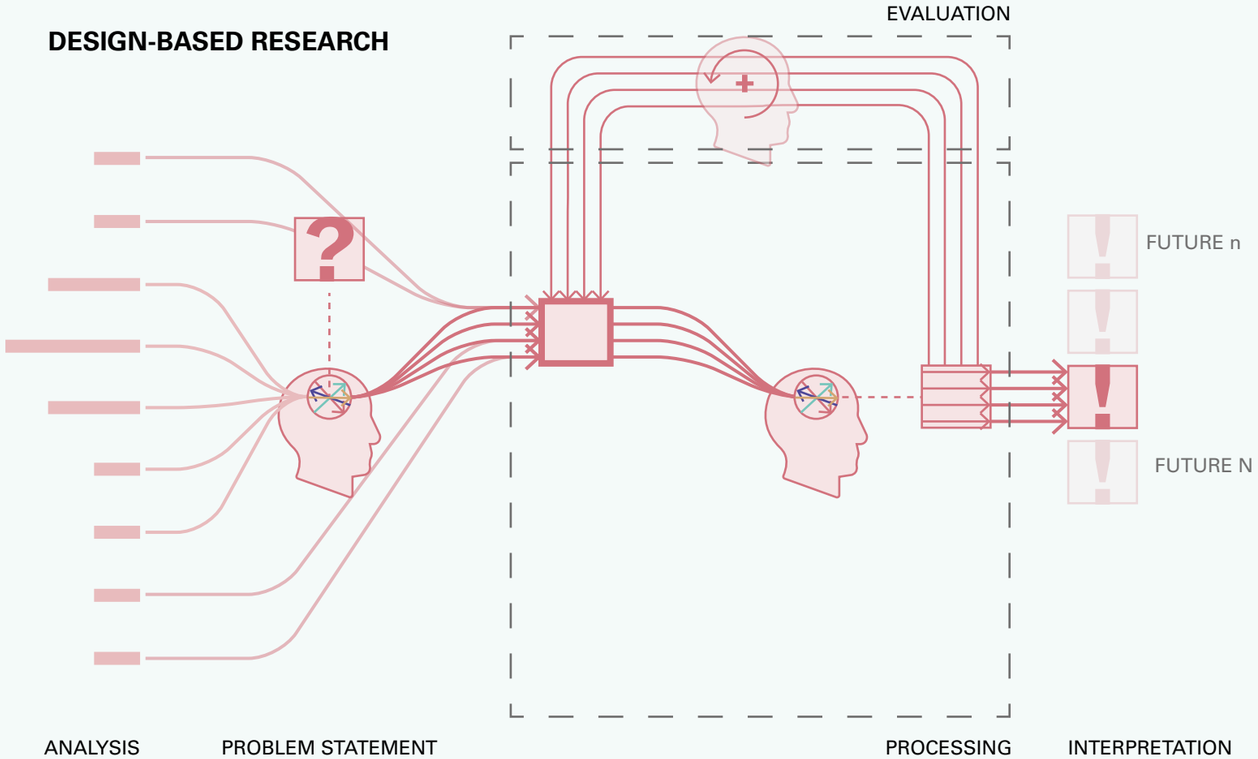
Image courtesy of Instituut Lorentz



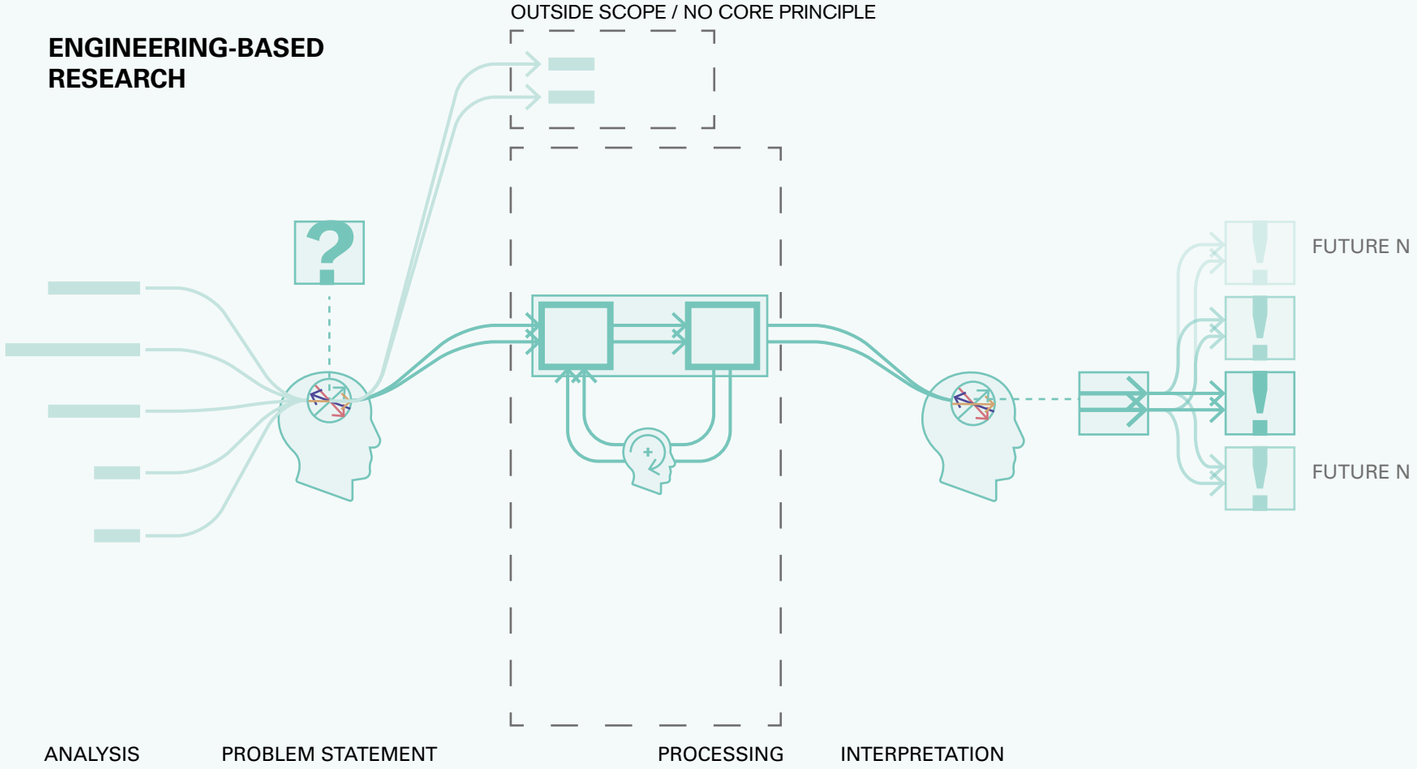




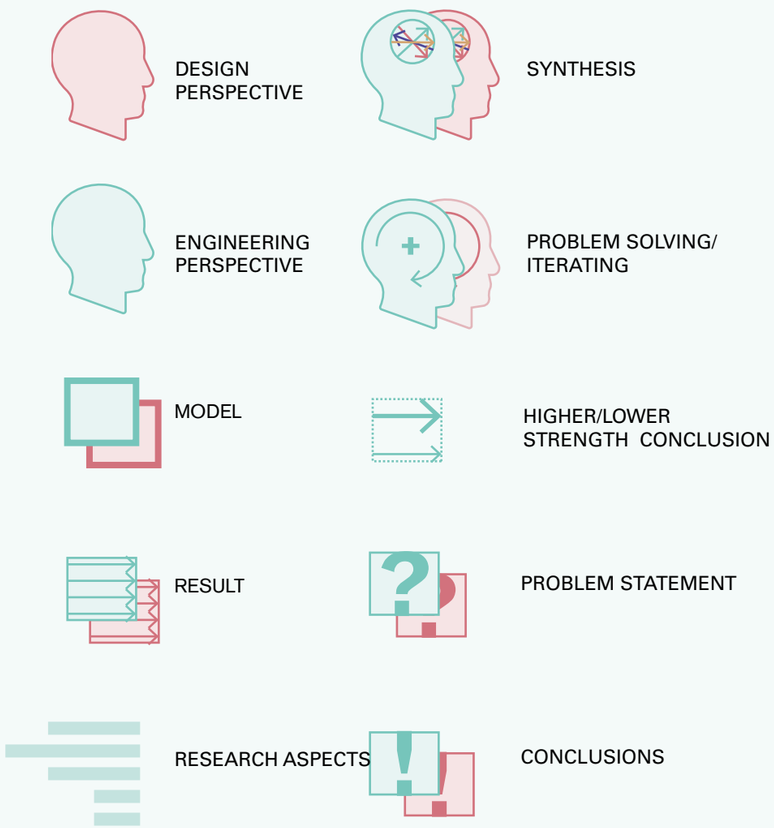
DESIGN-BASED RESEARCH



ENGINEERING-BASED RESEARCH



LEGEND



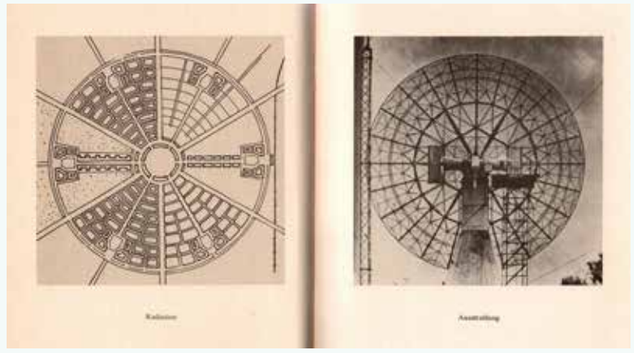
Fundaments	Engineering-based research	Design-based research
Goals	Derive general rules Objective interpretation Reproducible research	Elaborate on values and have impact Individual signature Creative approach/outcome
Domain	Scientific	Humanities and arts
Reported process	Sequential	Iterative
Models	Mathematical formulation	Visual representations of context
Variables	Quantitative	Qualitative
Scope	Narrowed down	Holistic

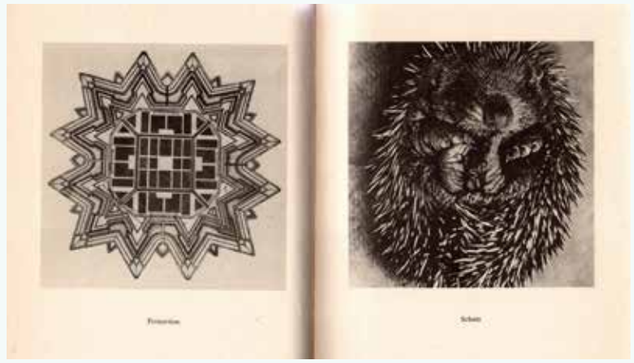
In research to urban planning problems...

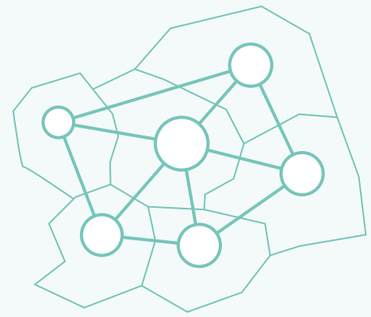
...The goal is not to raise an artefact
...The goal is to fill a knowledge gap

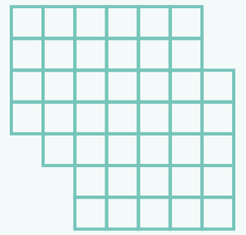
How can urban development be **steered** towards a **desired** goal in the future through **interventions**?

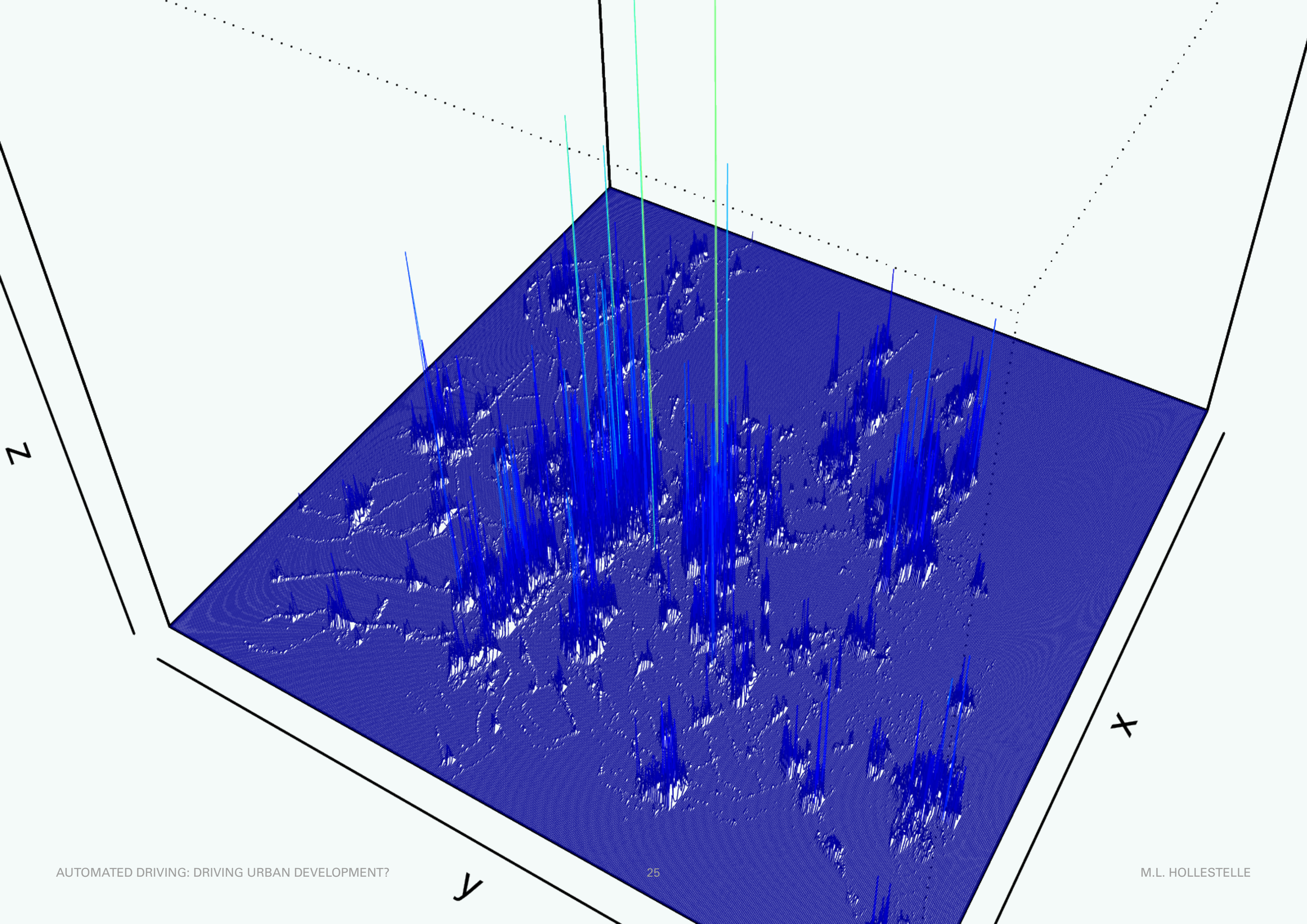
AN INTEGRATED APPROACH ASKS FOR A DIFFERENT LOOK AT CITIES

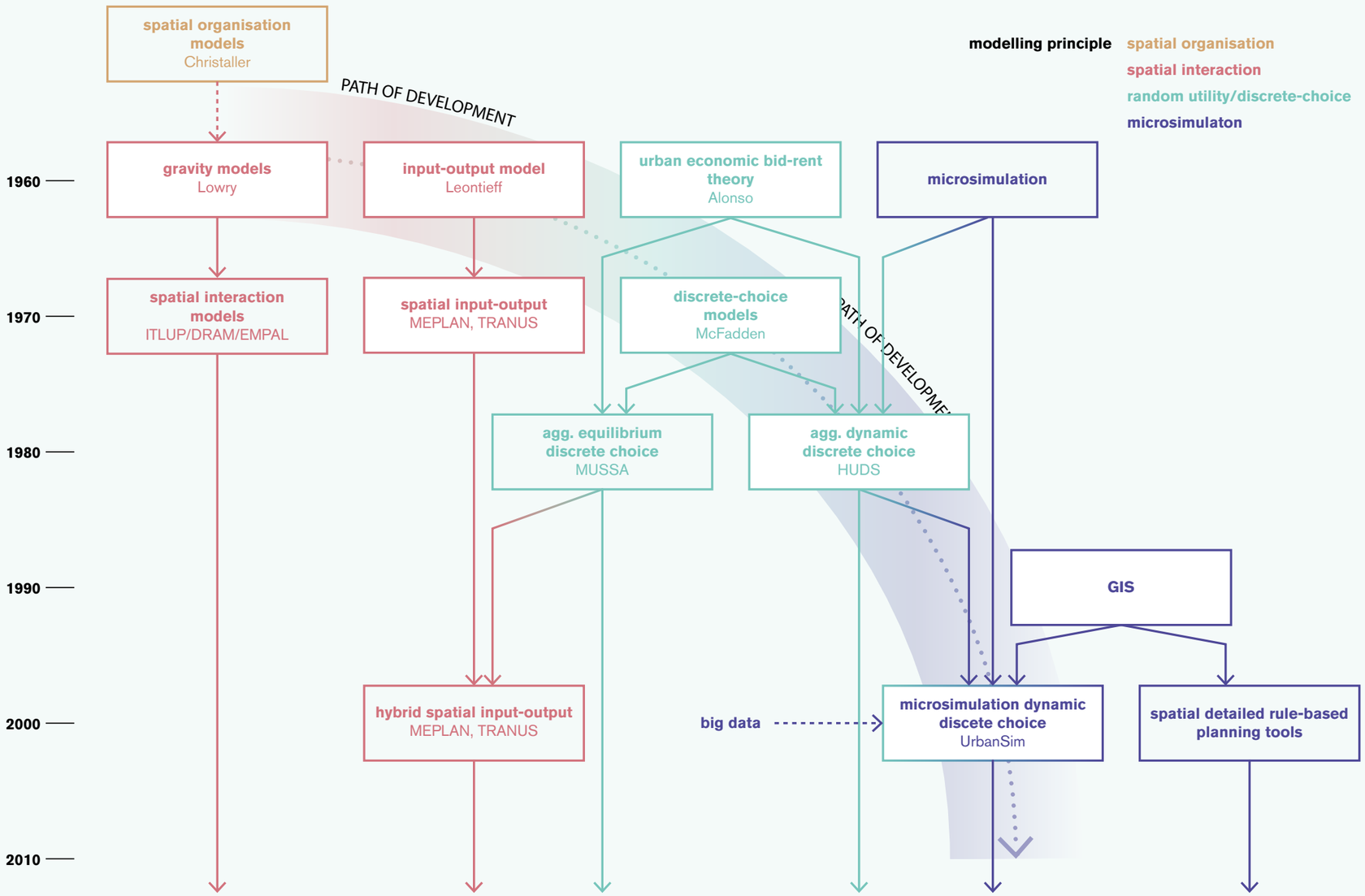


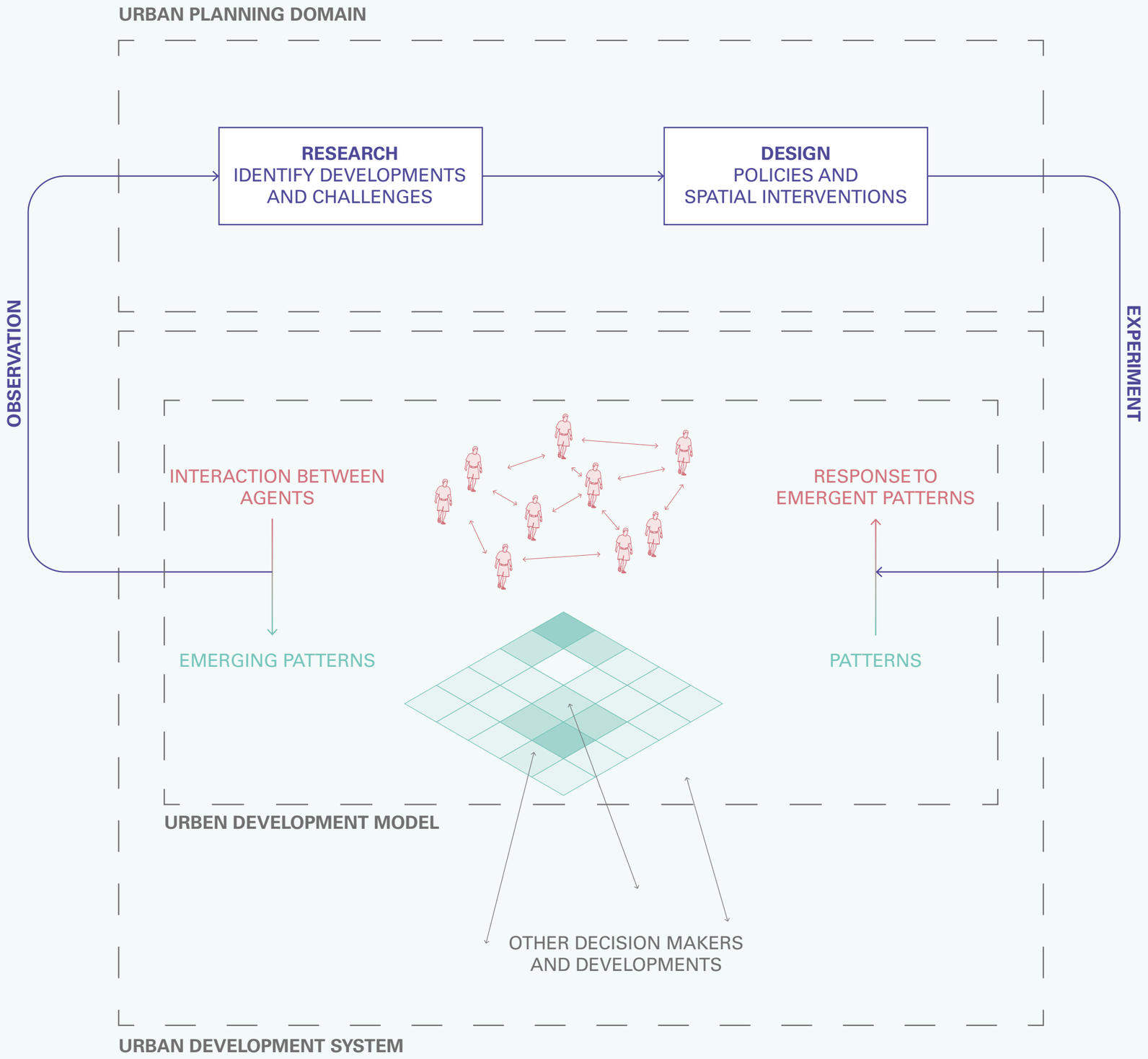




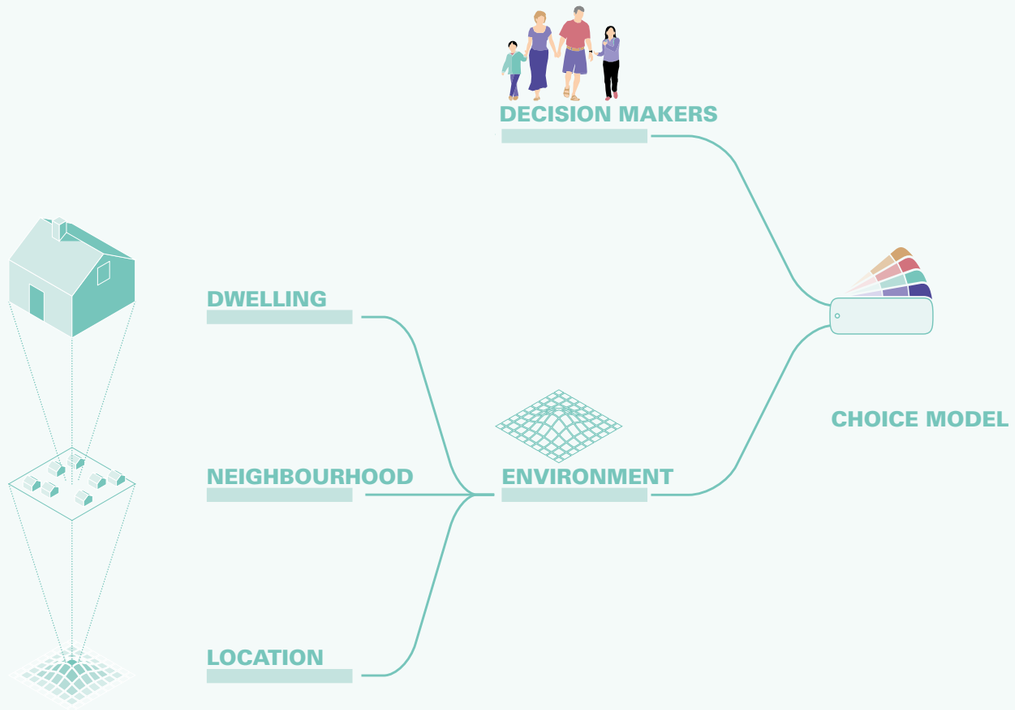



z
y
x


spatial organisation models
Christaller
PATH OF DEVELOPMENT
modelling principle
spatial organisation
spatial interaction
random utility/discrete-choice
microsimulaton
1960
gravity models
Lowry
input-output model
Leontieff
urban economic bid-rent theory
Alonso
microsimulation
1970
spatial interaction models
ITLUP/DRAM/EMPAL
spatial input-output
MEPLAN, TRANUS
discrete-choice models
McFadden
agg. equilibrium discrete choice
MUSSA
agg. dynamic discrete choice
HUDS
1980
1990
GIS
2000
hybrid spatial input-output
MEPLAN, TRANUS
big data
microsimulation dynamic discete choice
UrbanSim
spatial detailed rule-based planning tools
2010


URBAN PLANNING DOMAIN
RESEARCH
IDENTIFY DEVELOPMENTS
AND CHALLENGES
DESIGN
POLICIES AND
SPATIAL INTERVENTIONS
OBSERVATION
EXPERIMENT
INTERACTION BETWEEN
AGENTS
RESPONSE TO
EMERGENT PATTERNS
EMERGING PATTERNS
PATTERNS
URBEN DEVELOPMENT MODEL
OTHER DECISION MAKERS
AND DEVELOPMENTS
URBAN DEVELOPMENT SYSTEM

THE CASE STUDY OF AUTOMATED DRIVING



centre-urban plus

centre-urban

centre-small-urban

urban pre-war

urban post-war compact

urban post-war ground-level

small-urban

green-urban

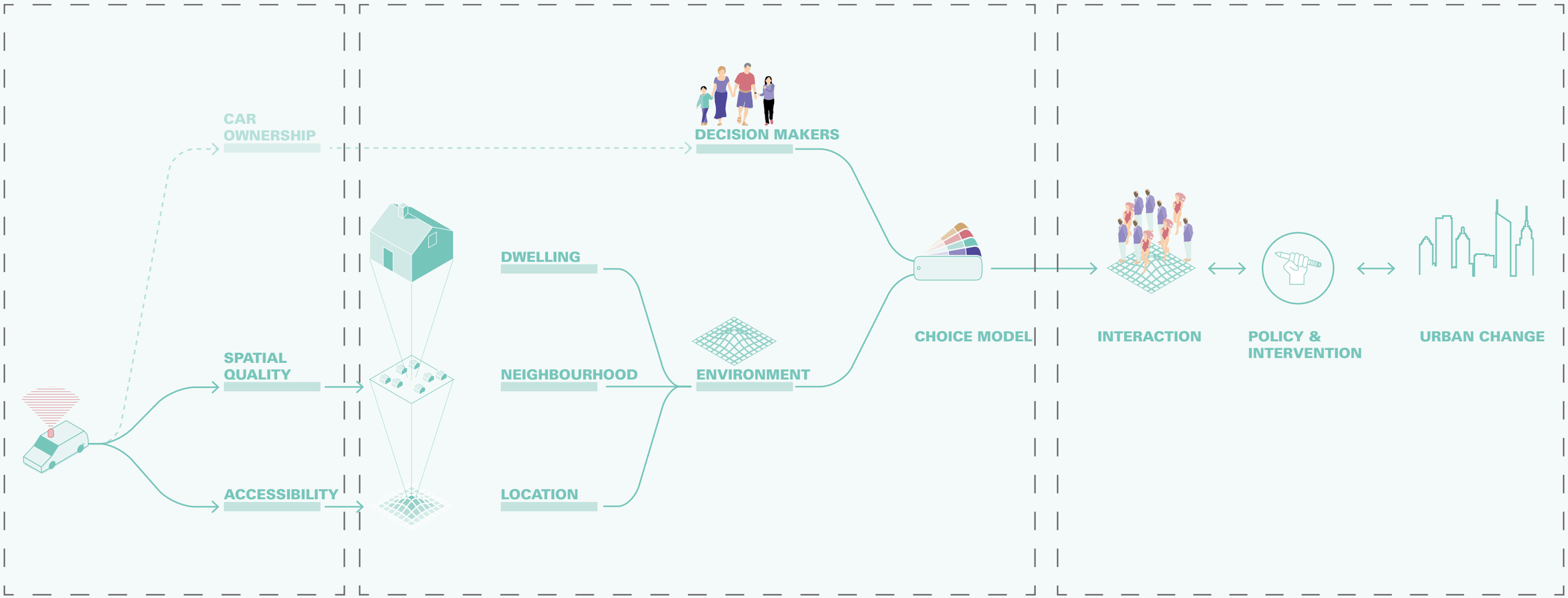
green-small-urban

centre-village

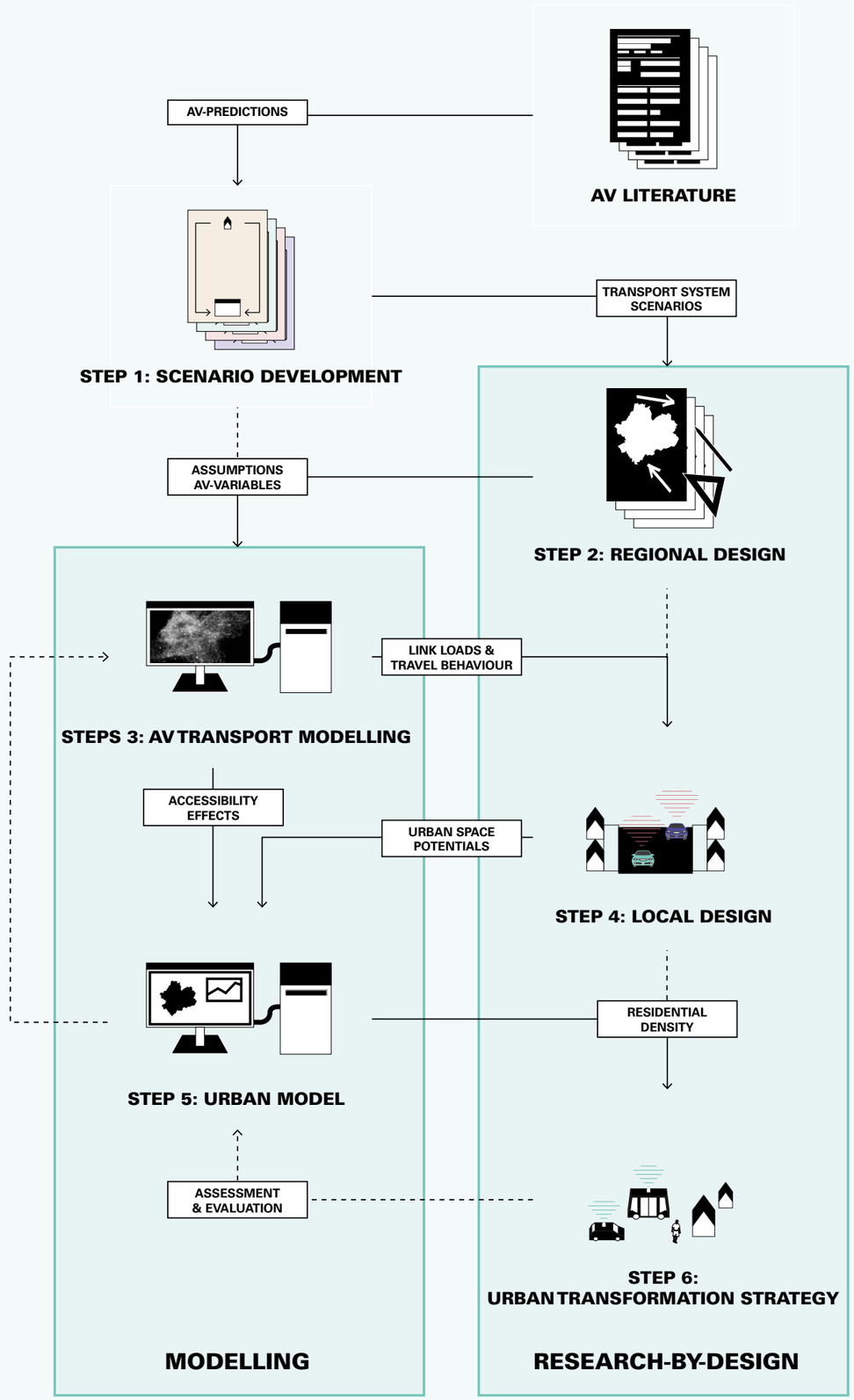
village

rural

THE CASE STUDY OF AUTOMATED DRIVING

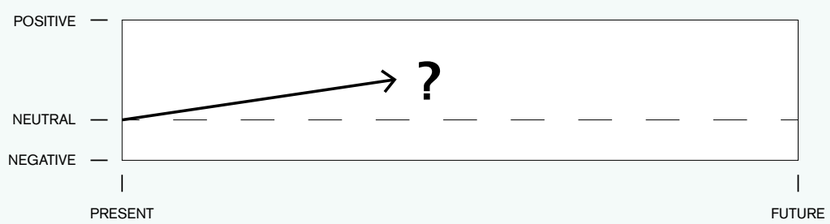


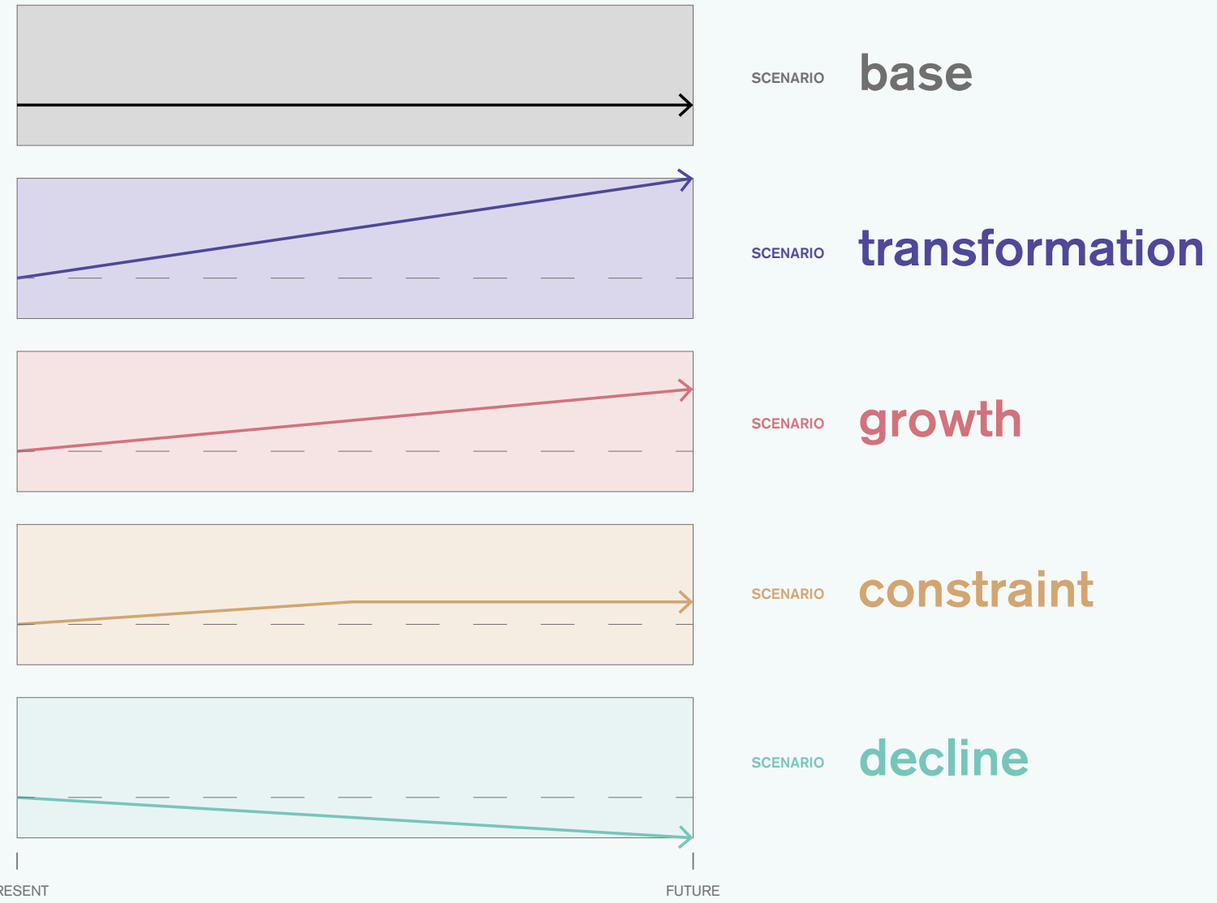
RESEARCH STRUCTURE

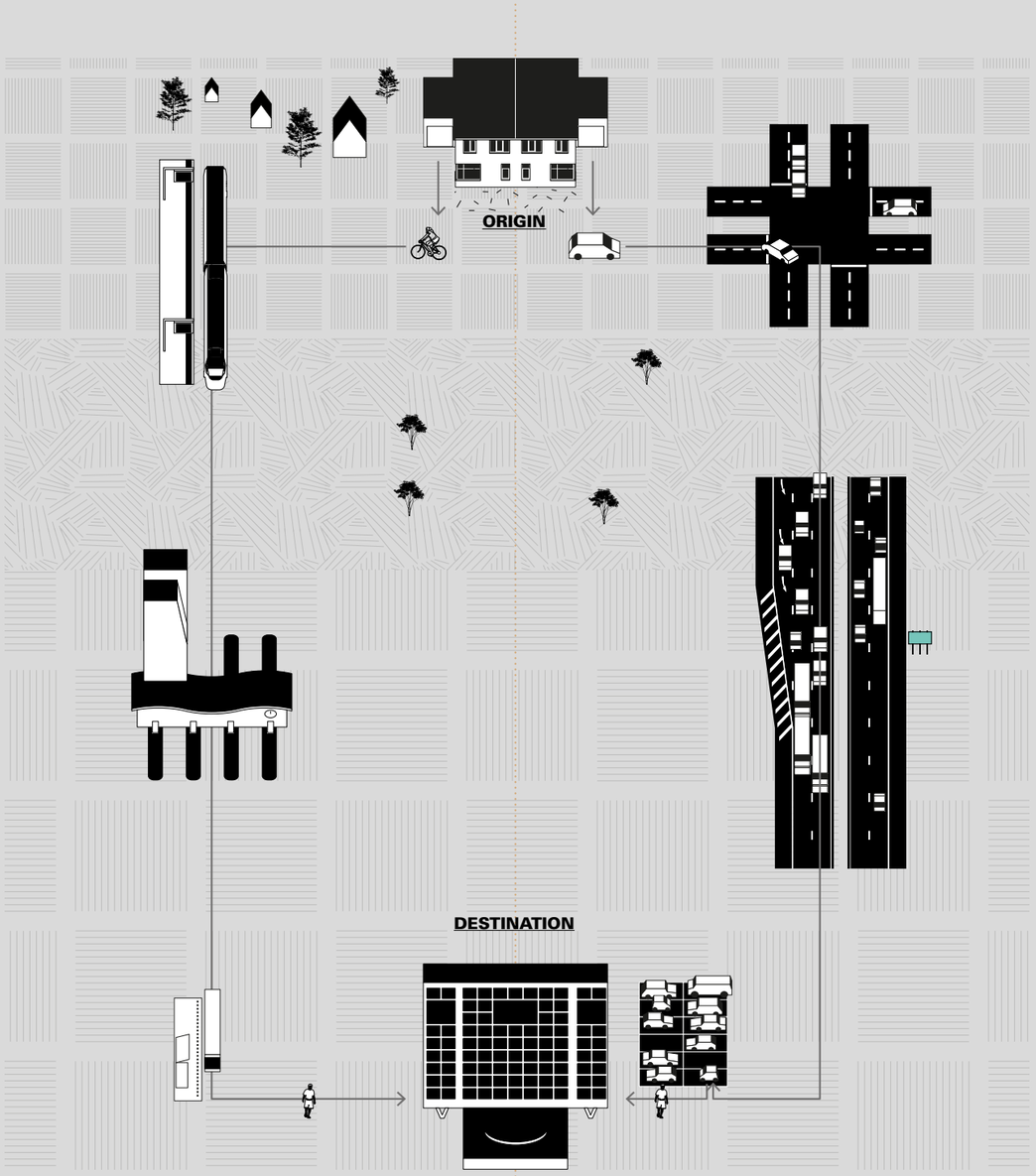


CASE STUDY AREA

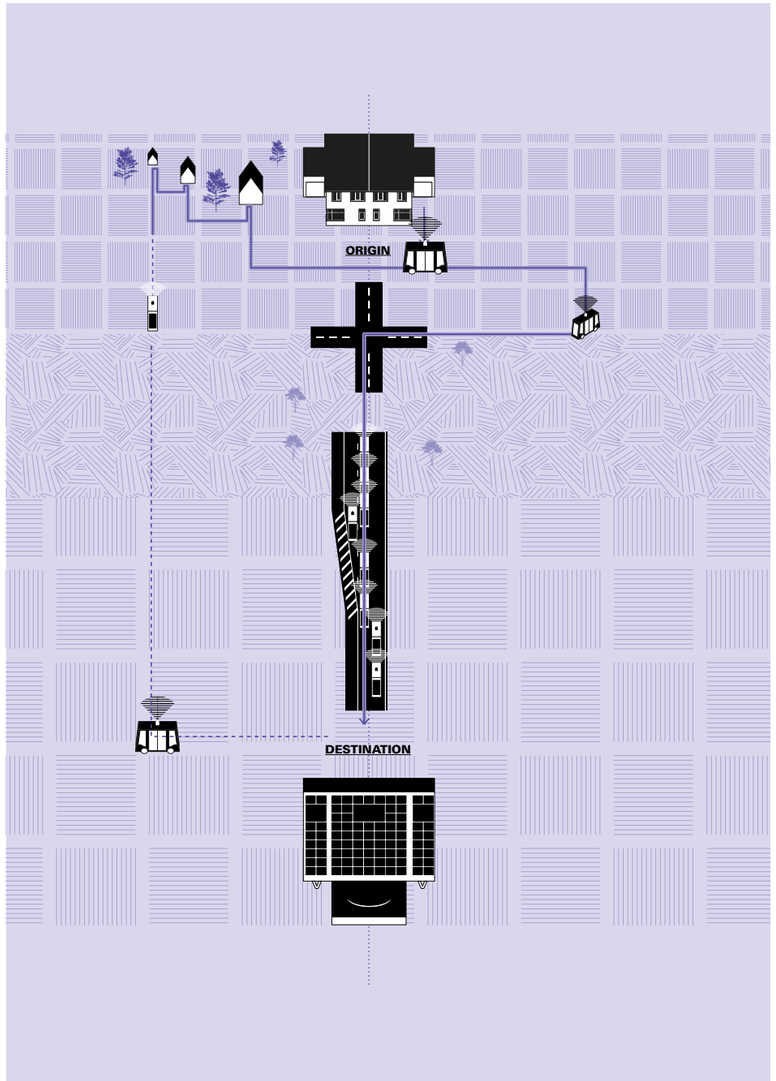
SCENARIO APPROACH



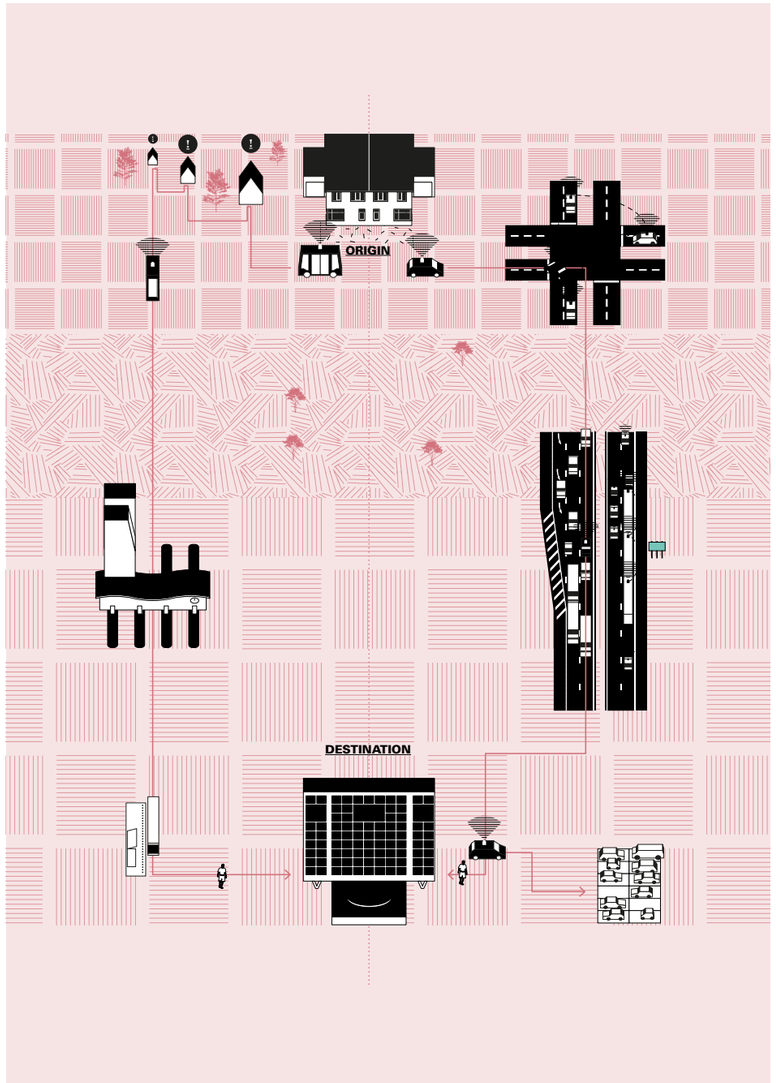


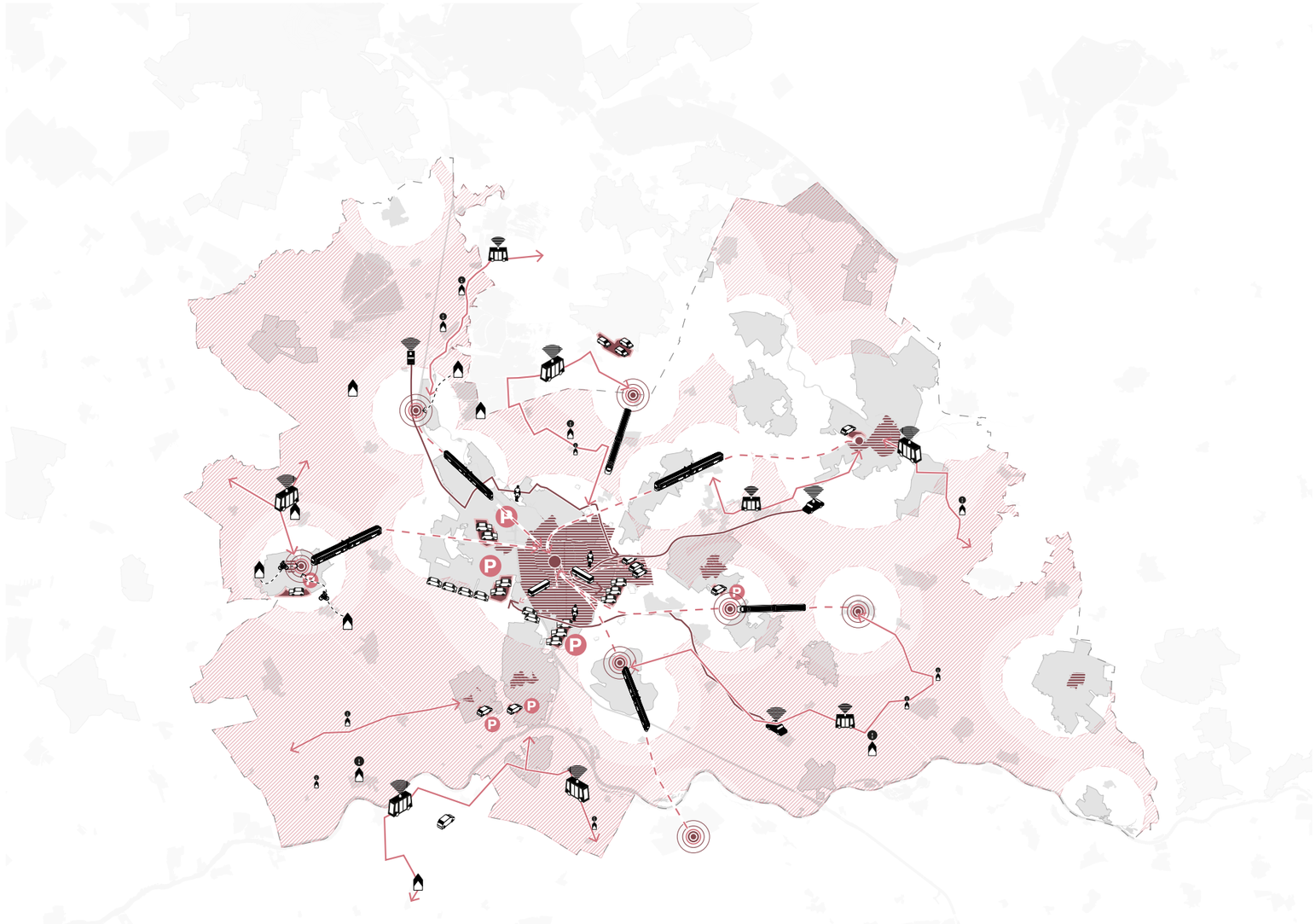

ORIGIN
DESTINATION

transformation

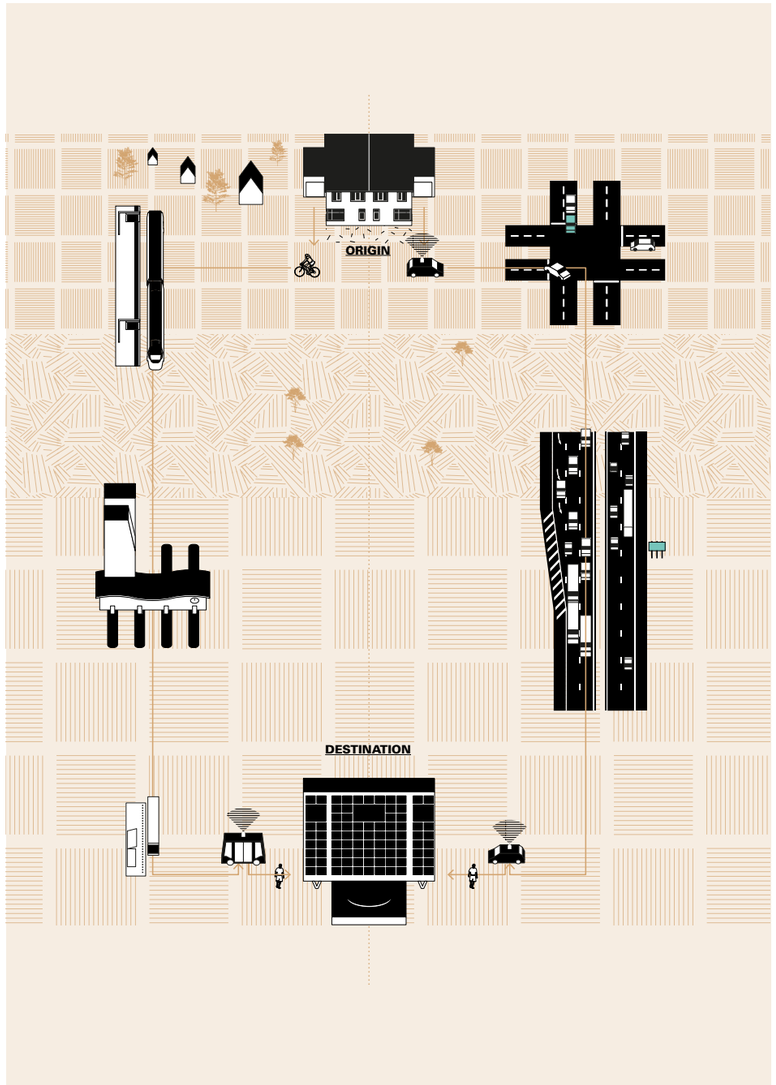


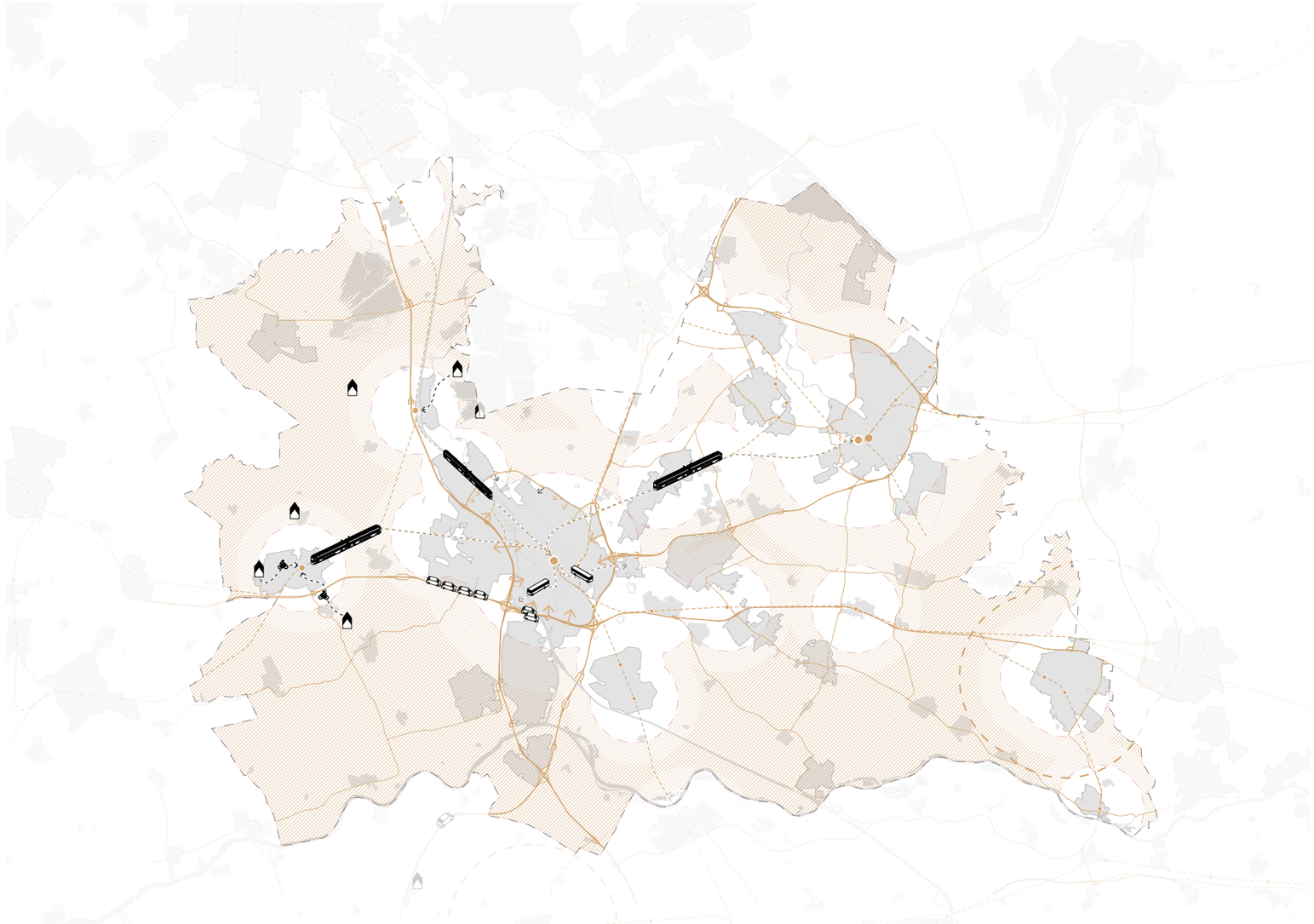
growth



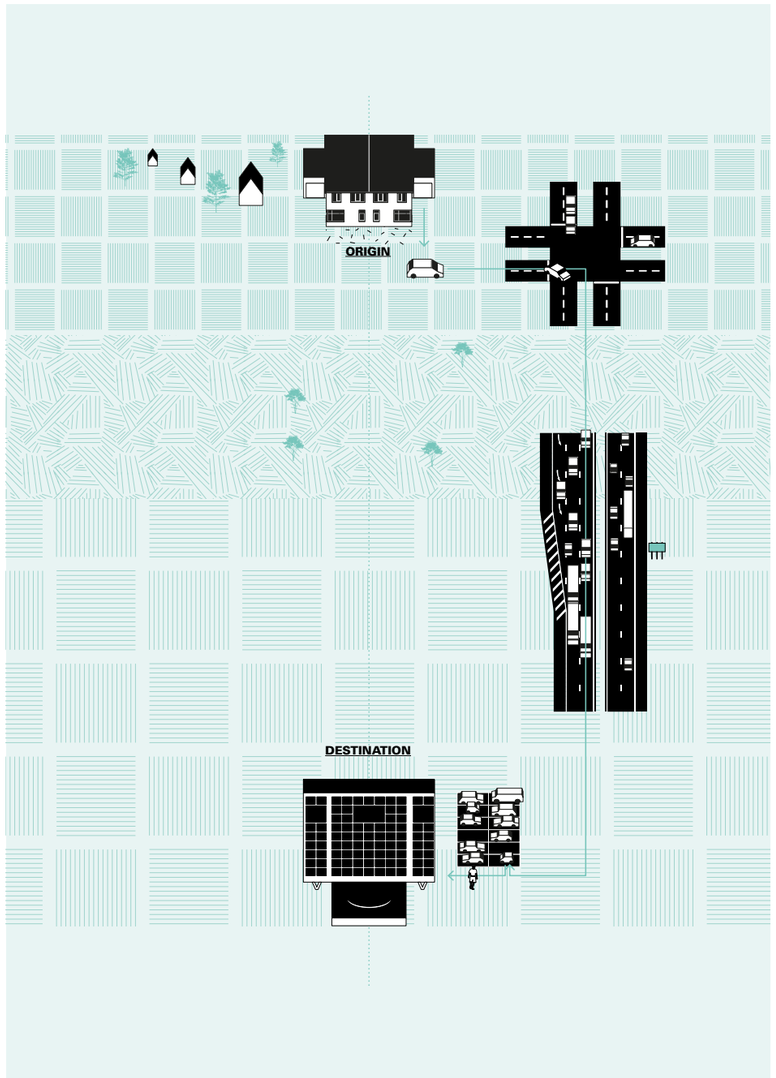


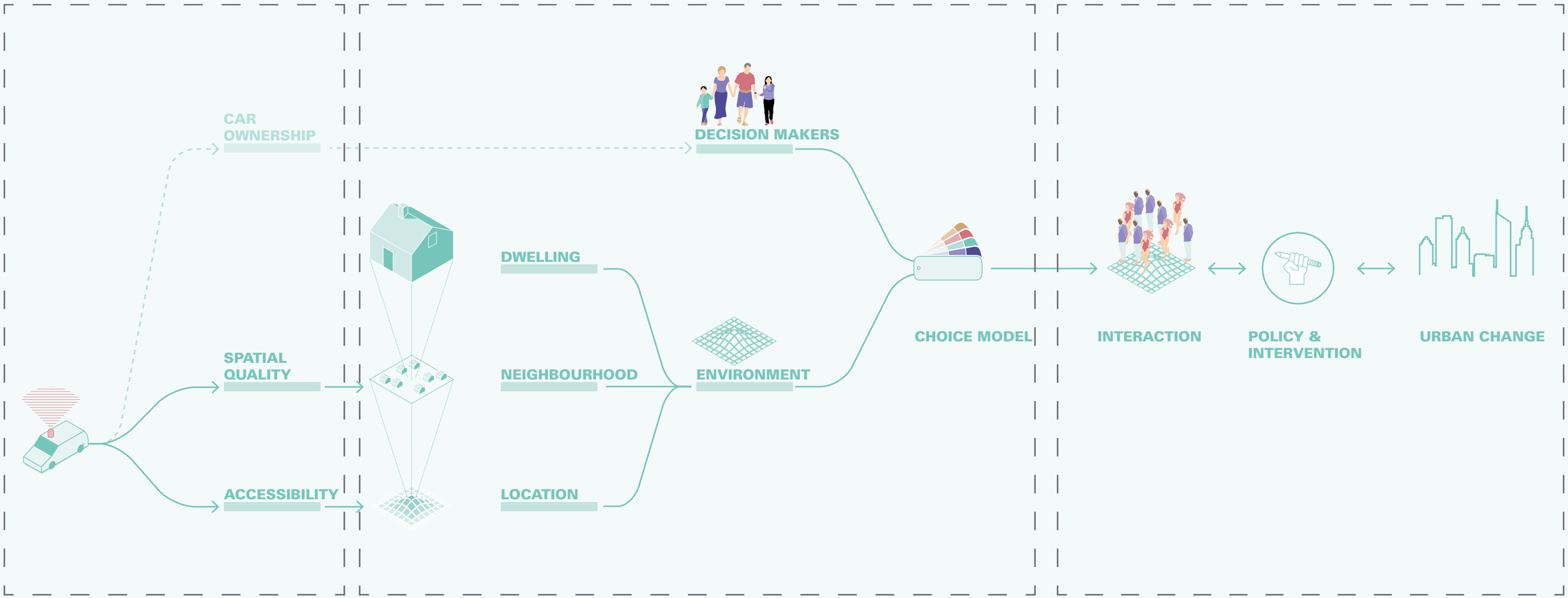
constraint



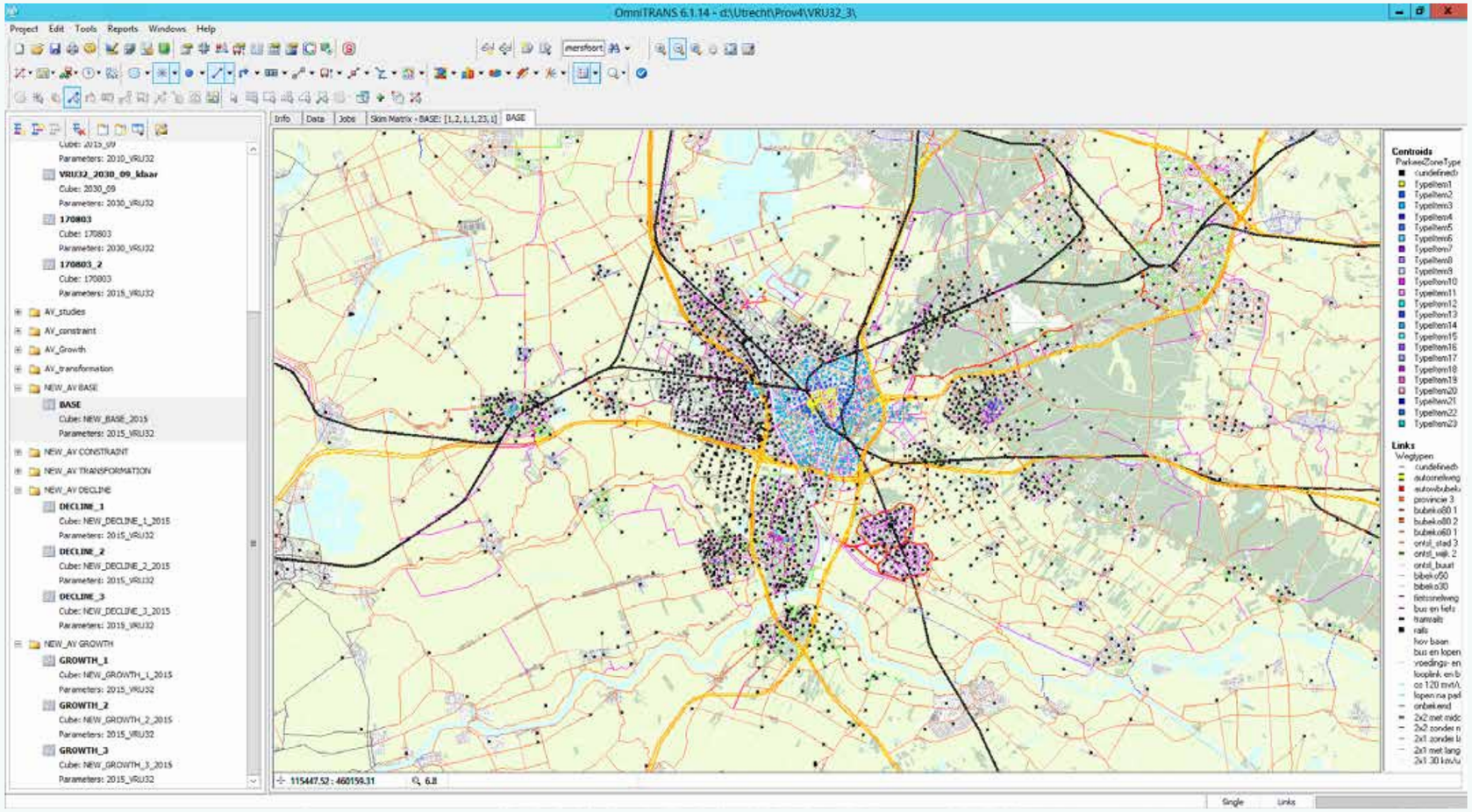


decline

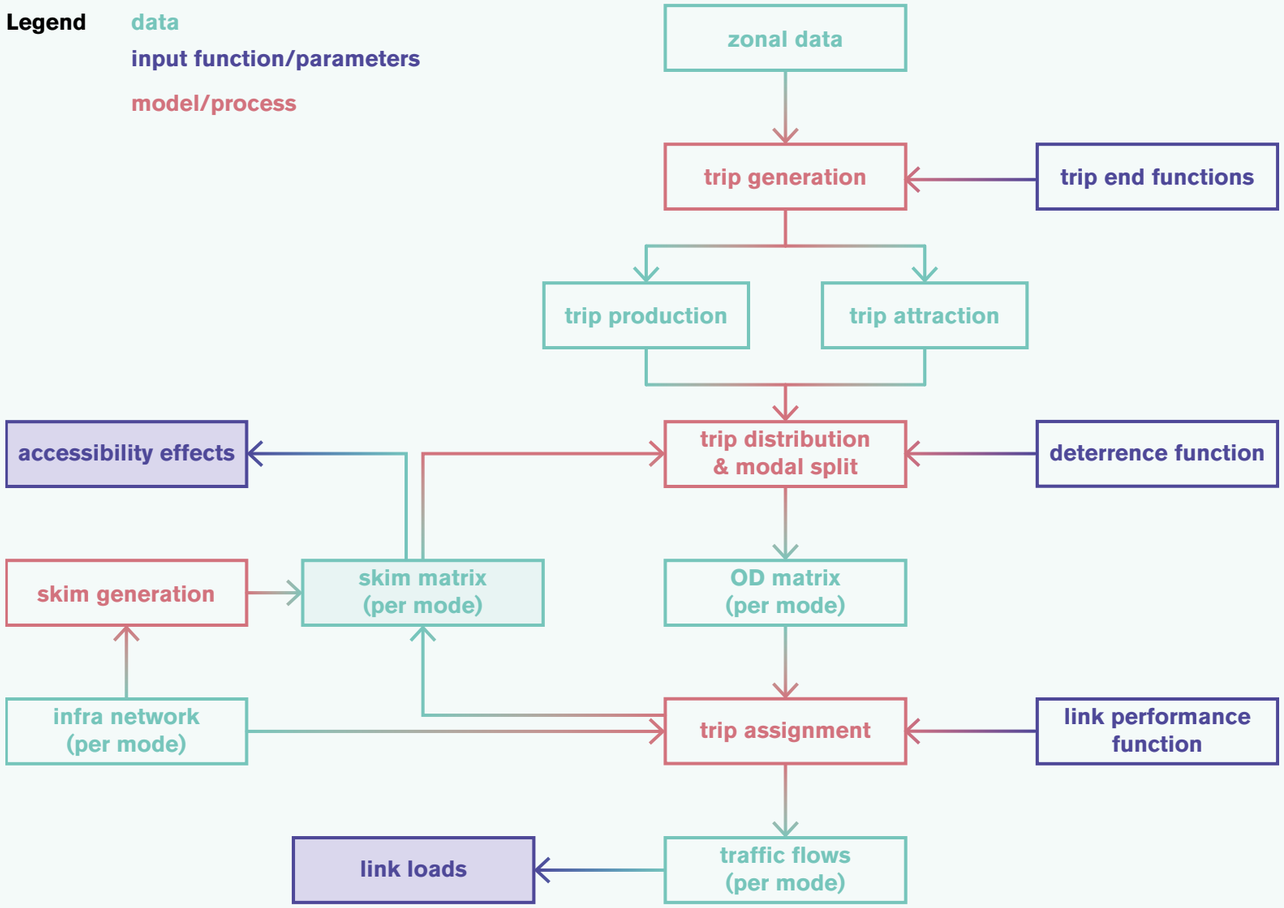



CAR OWNERSHIP
SPATIAL QUALITY
ACCESSIBILITY
DWELLING
NEIGHBOURHOOD
LOCATION
DECISION MAKERS
ENVIRONMENT
CHOICE MODEL
INTERACTION
POLICY & INTERVENTION
URBAN CHANGE
AUTOMATED DRIVING
DRIVING FORCES IN URBAN DEVELOPMENT
URBAN DEVELOPMENT PROCESS

ACCESSIBILITY AND TRAVEL EFFECTS



HOW TO MODEL AUTOMATED VEHICLES?



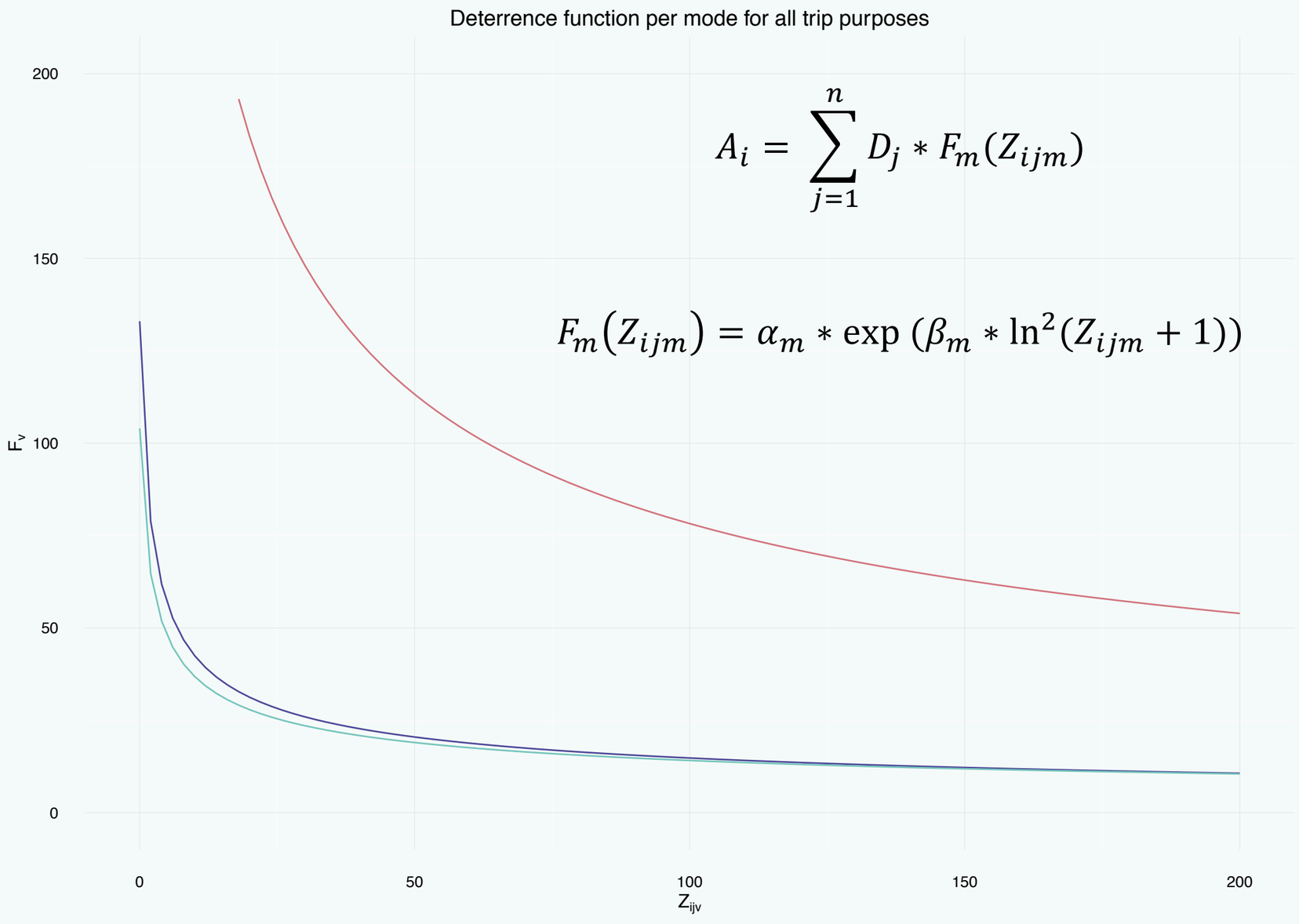
How to model self-driving cars?

- Value of time changes
- Route factors
- OD-matrix mutation
- Infrastructure capacity

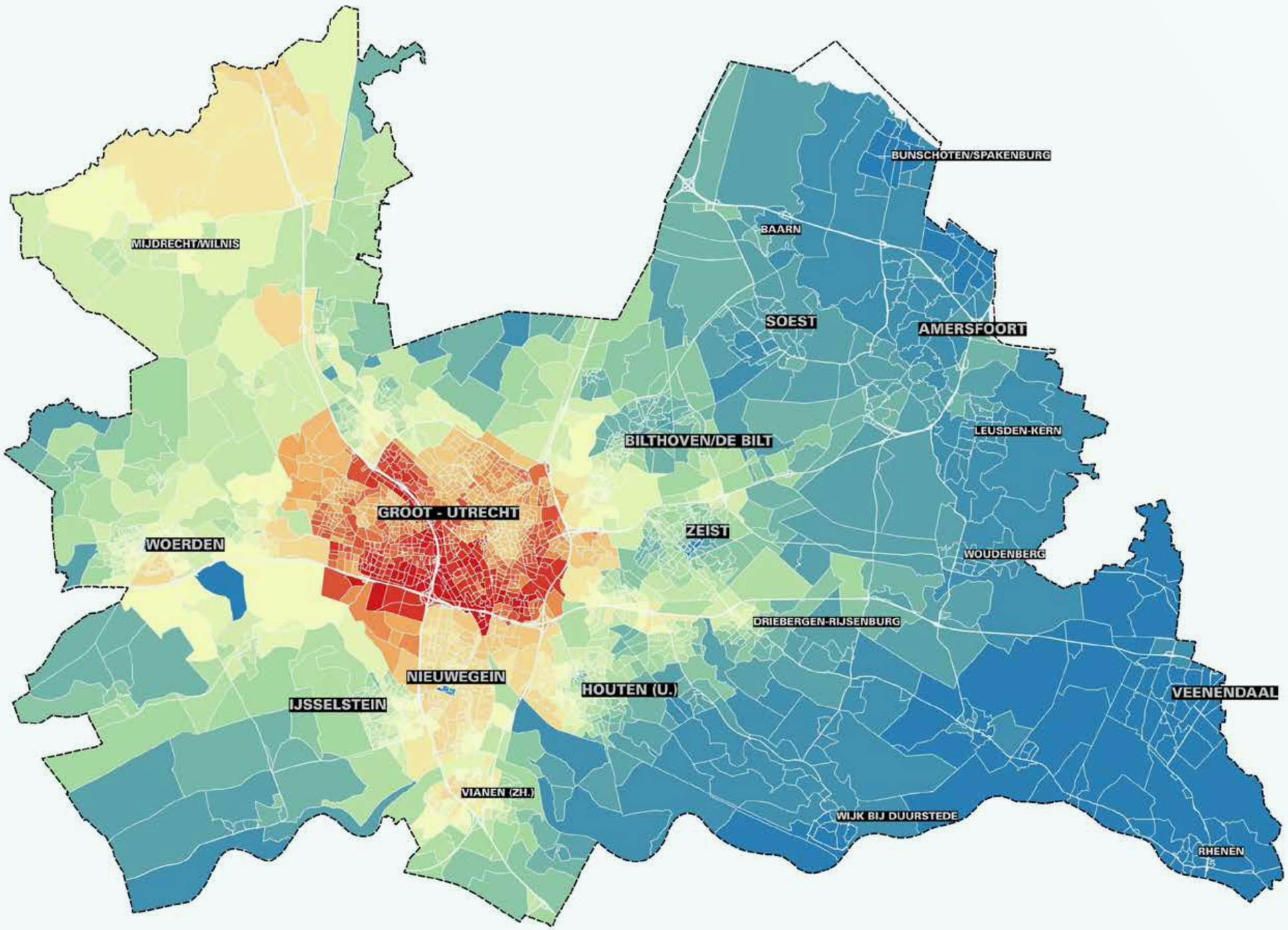
ACCESSIBILITY CALCULATION

$$A_i = \sum_{j=1}^{n} D_j * F_m(Z_{ijm})$$

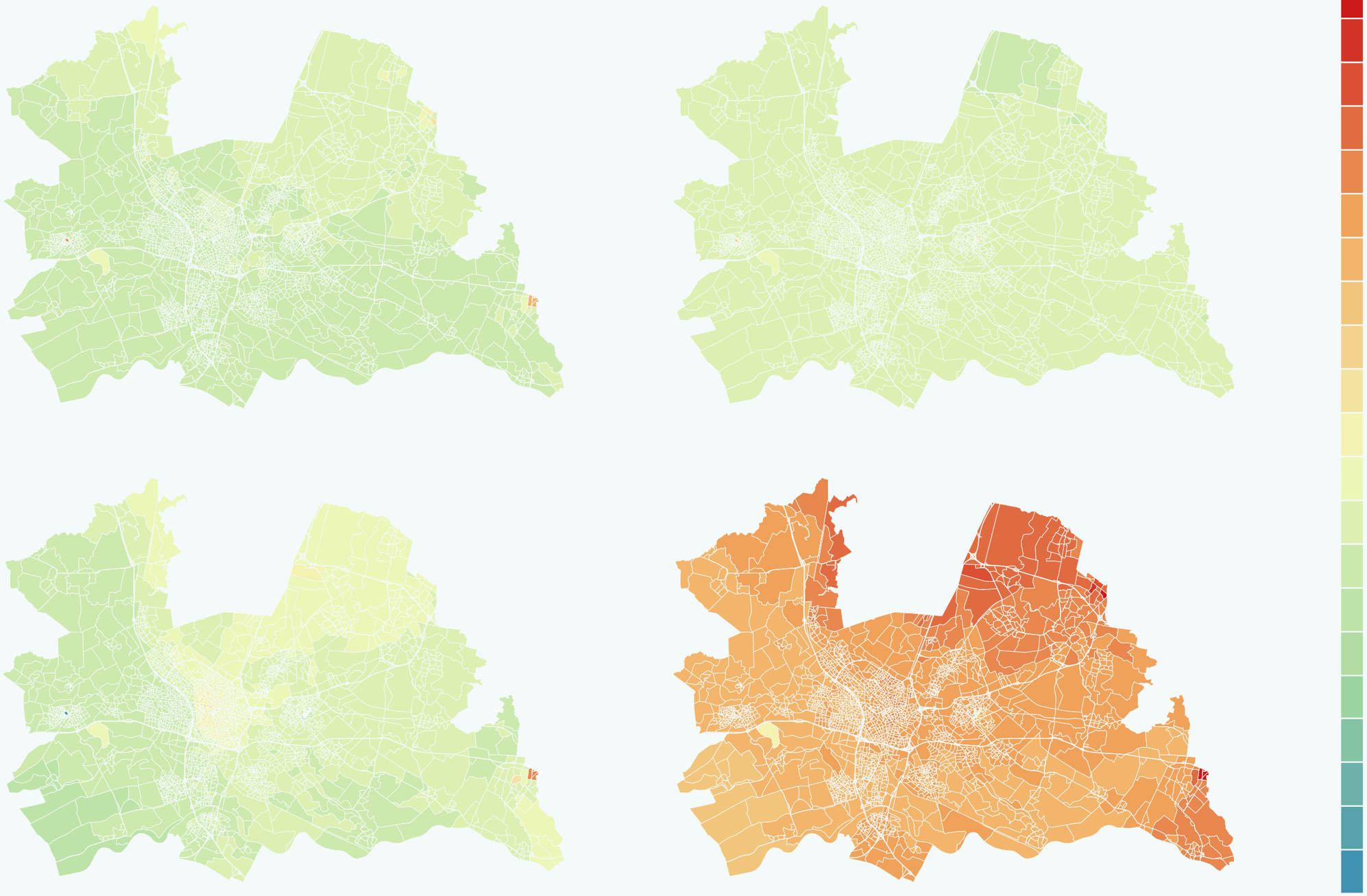
$$F_m(Z_{ijm}) = \alpha_m * \exp\left(\beta_m * \ln^2(Z_{ijm} + 1)\right)$$



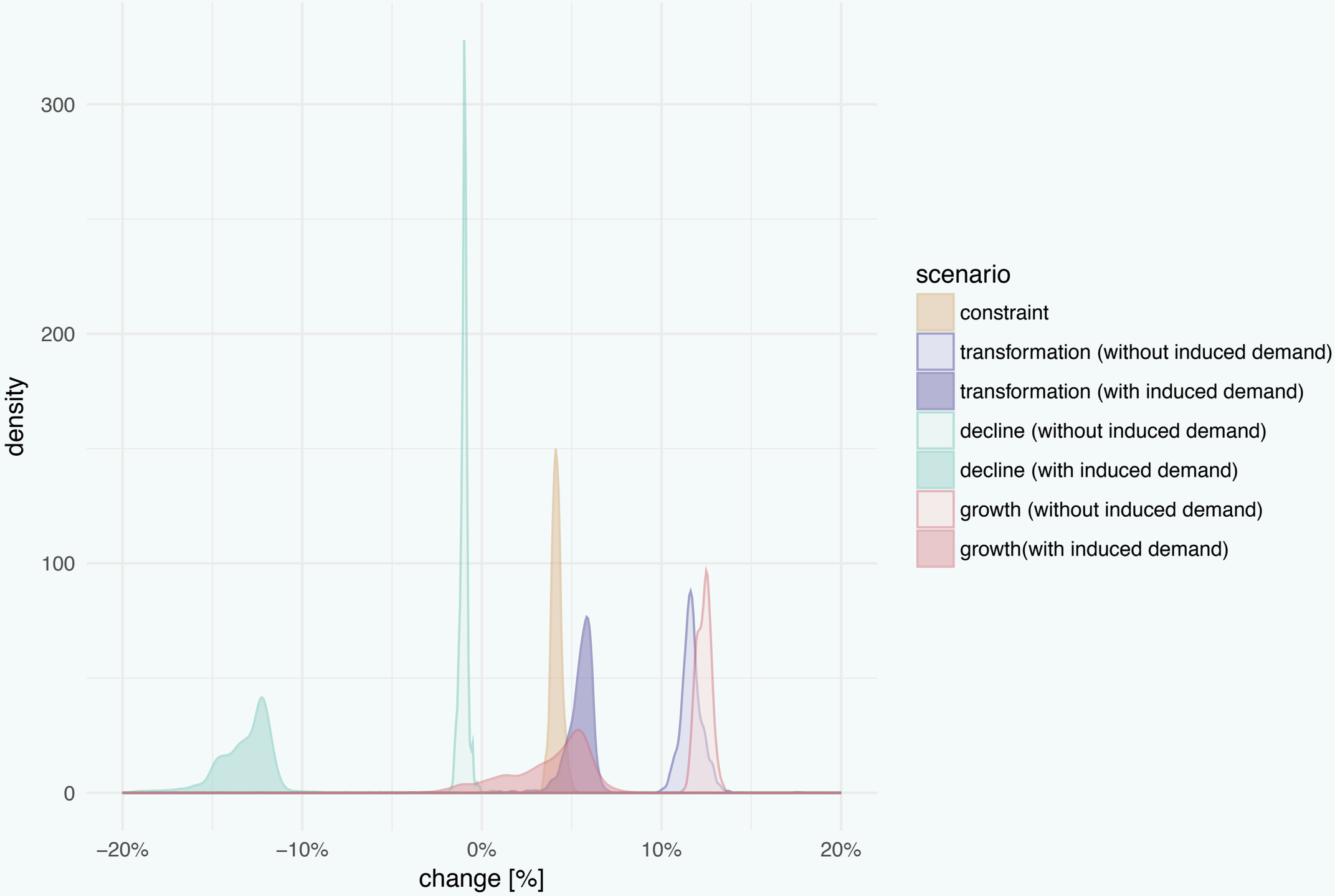
BASE YEAR ACCESSIBILITY



ACCESSIBILITY CHANGES

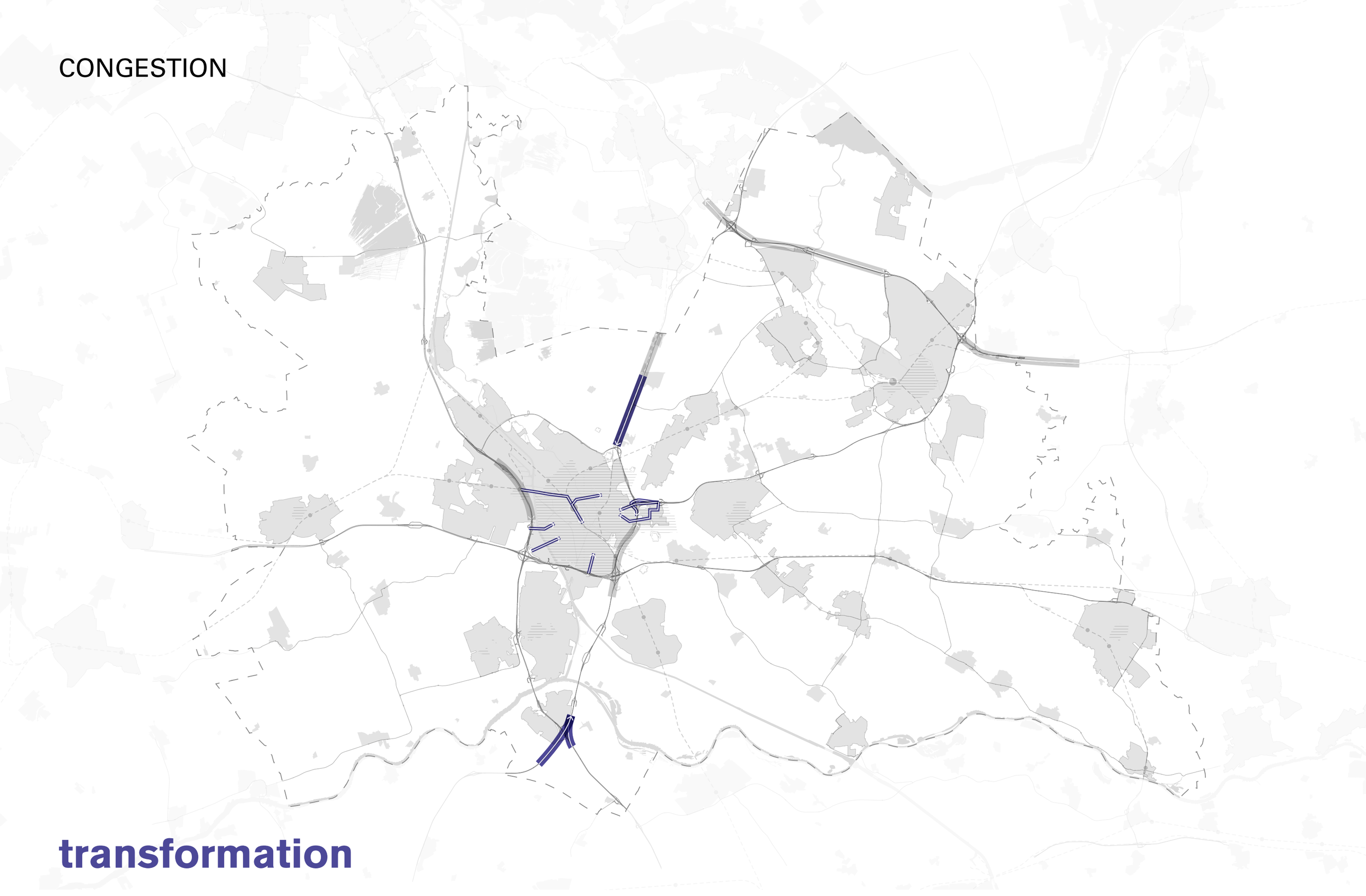


relative change in accessibility of VRU zones by scenario (2500 zones)



CONGESTIONS

CONGESTION



transformation

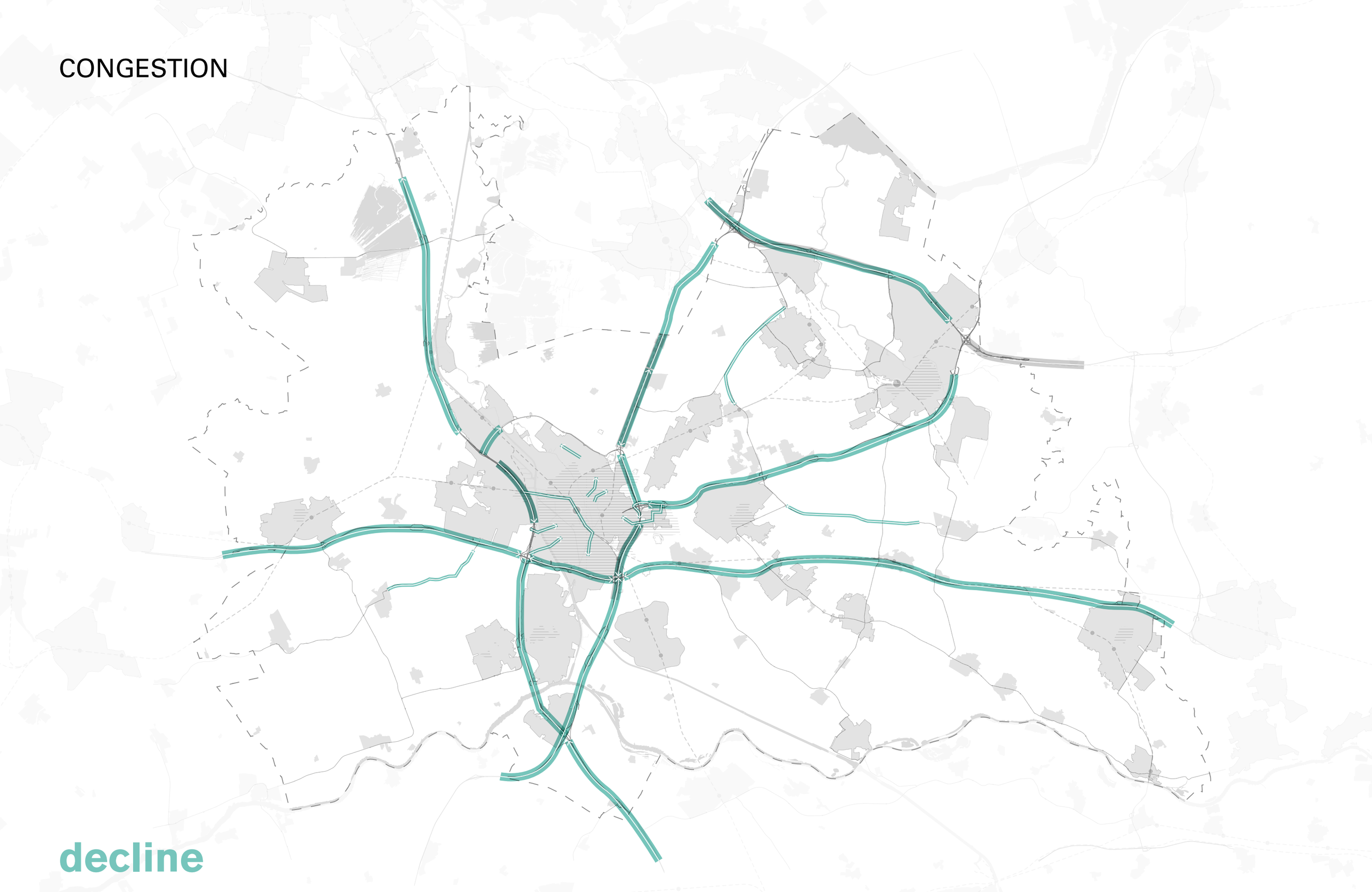
CONGESTION

growth

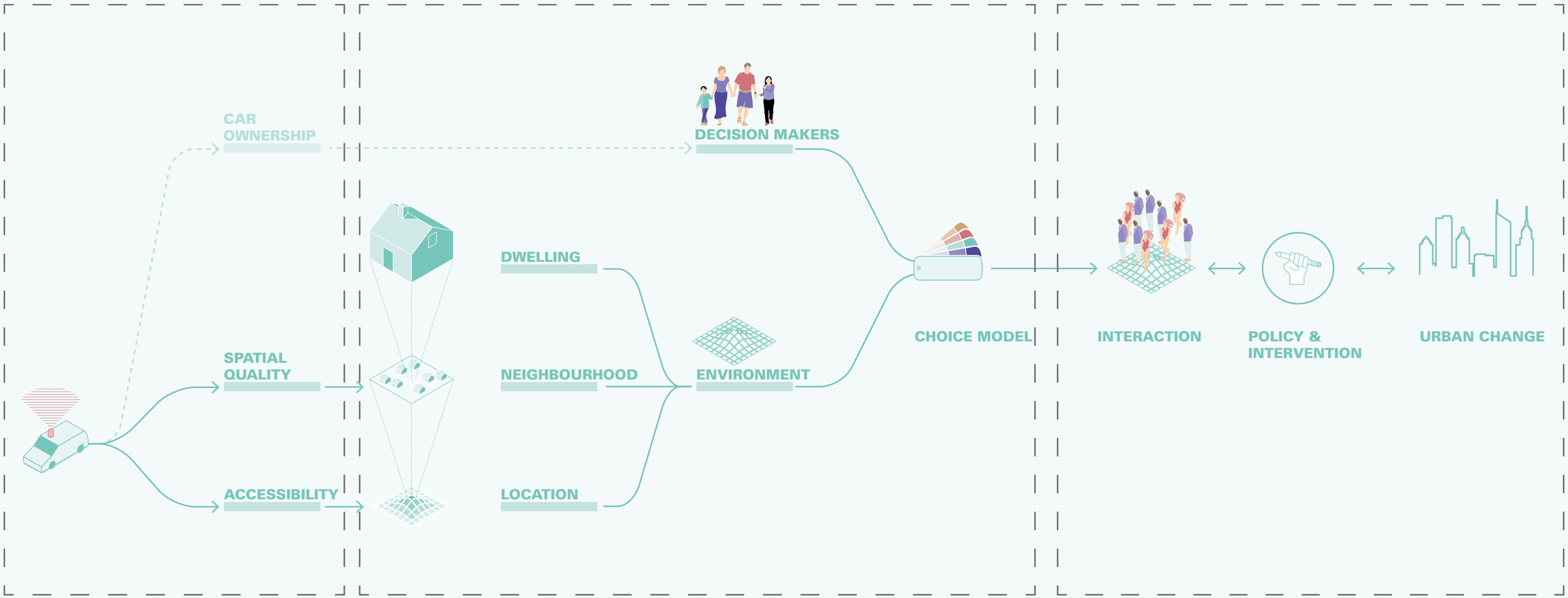
CONGESTION

constraint

CONGESTION



decline


CAR OWNERSHIP
DECISION MAKERS
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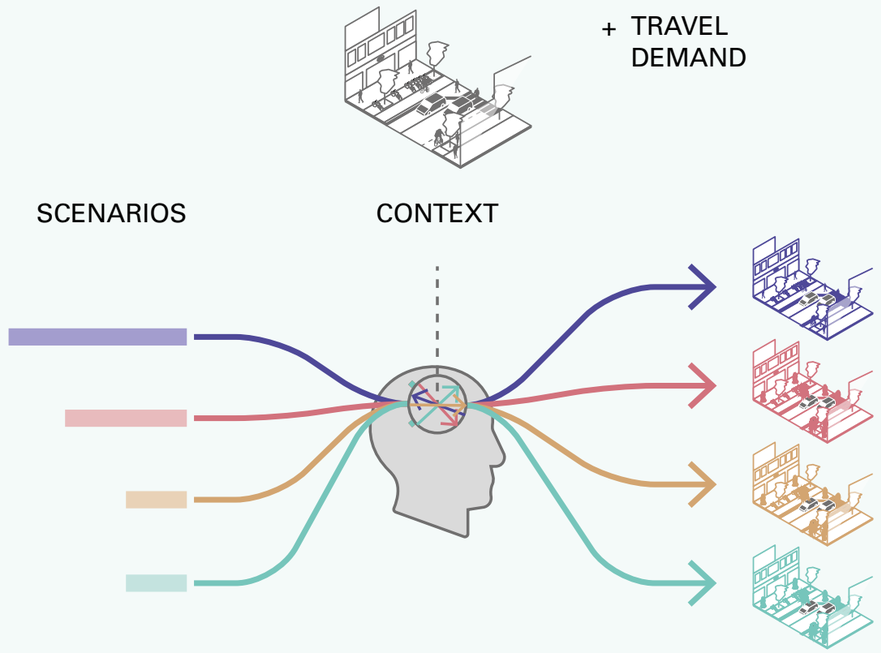
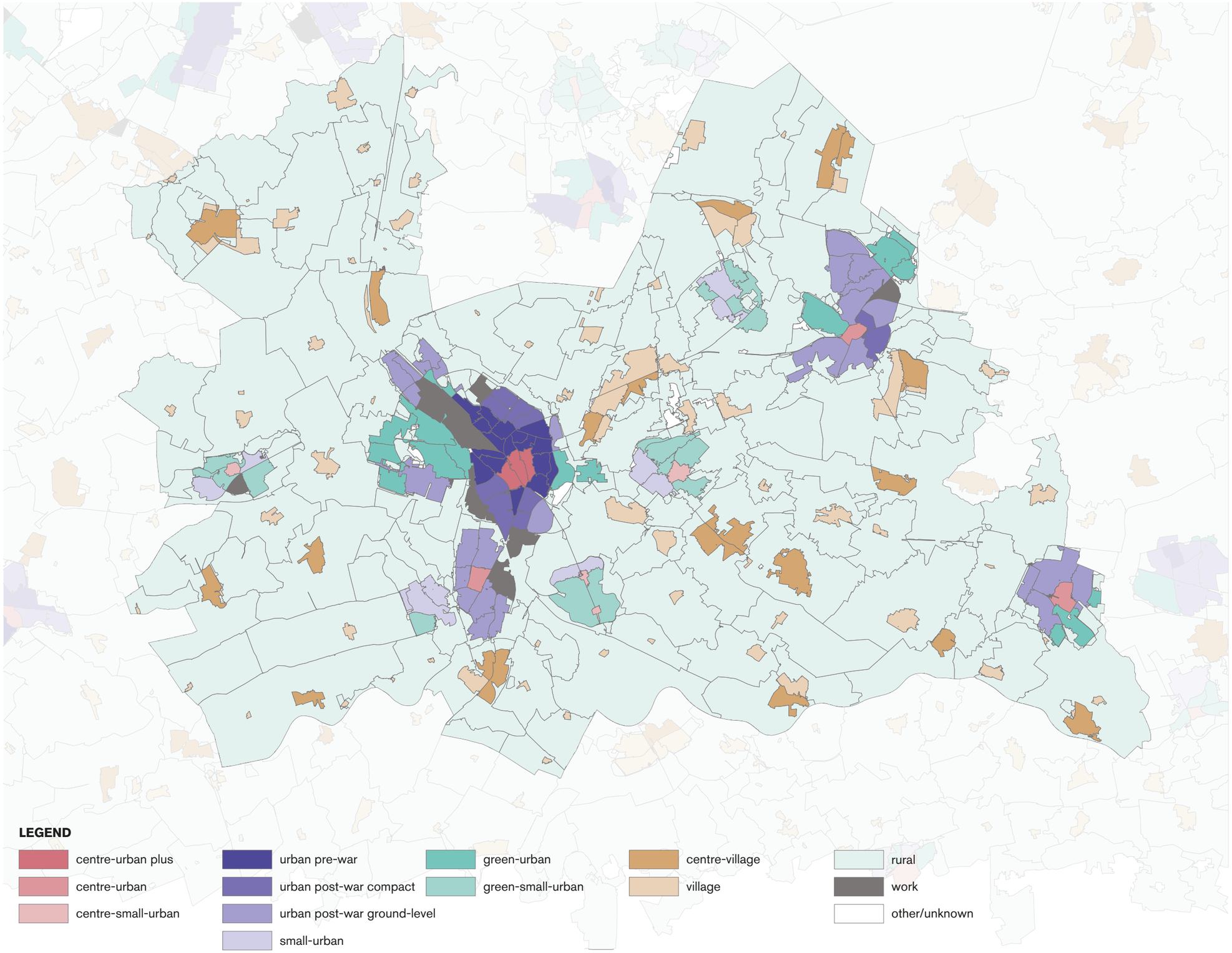
INTERACTION
POLICY & INTERVENTION
URBAN CHANGE
AUTOMATED DRIVING
DRIVING FORCES IN URBAN DEVELOPMENT
URBAN DEVELOPMENT PROCESS


+ TRAVEL
DEMAND
SCENARIOS
CONTEXT

NEIGHBOURHOOD TYPOLOGIES



HWM1: CENTRE URBAN PLUS

HWM2: CENTRE URBAN

HWM3: CENTRE SMALL URBAN

HWM4: URBAN PRE-WAR

HWM5: URBAN POST-WAR COMPACT

HWM6: URBAN POST-WAR LAND-BASED

HWM7: SMALL URBAN

HWM8: GREEN-URBAN

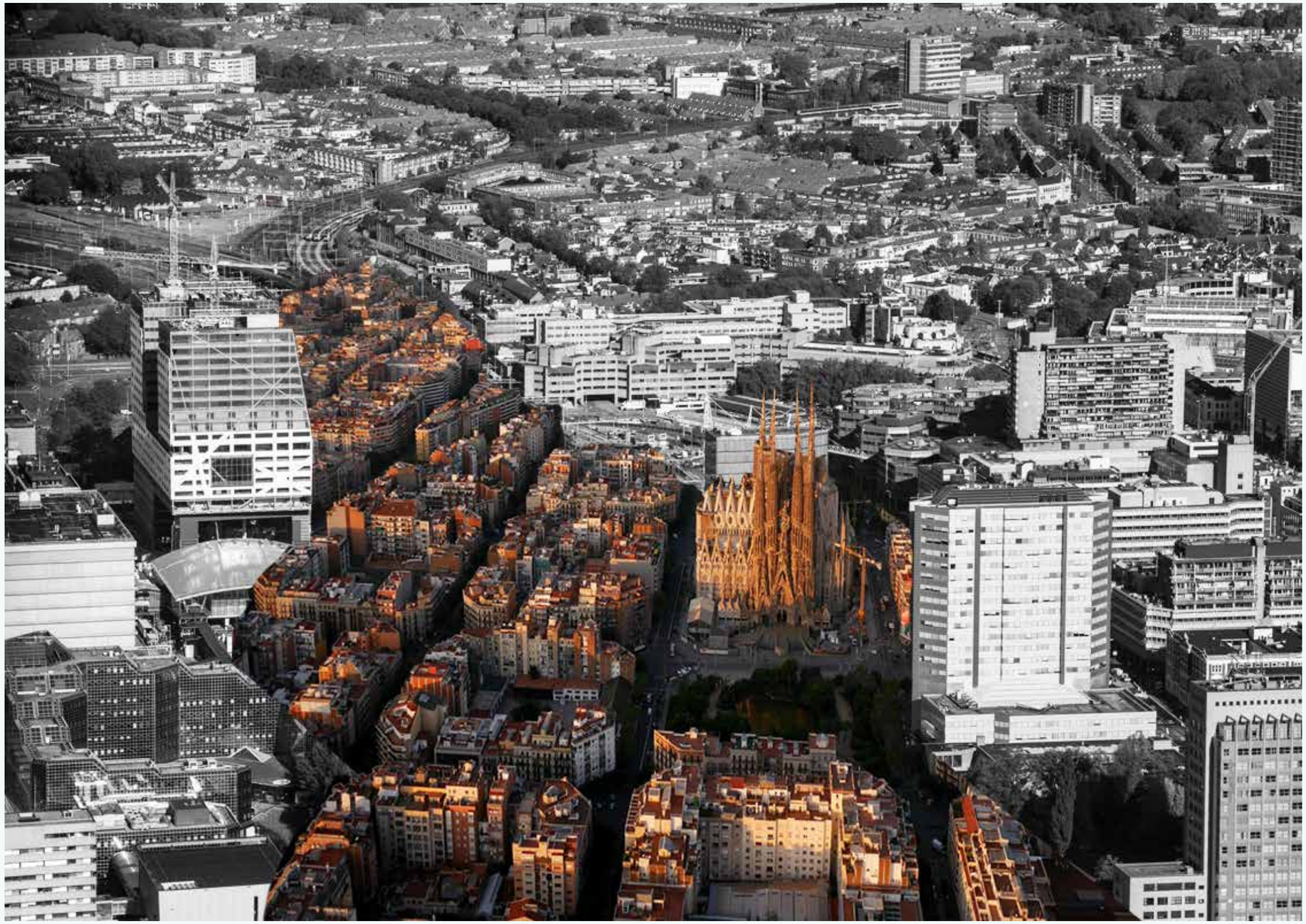
HWM9: GREEN-SMALL-URBAN

HWM10: CENTRE-VILLAGE

HWM11: VILLAGE

HWM12: RURAL

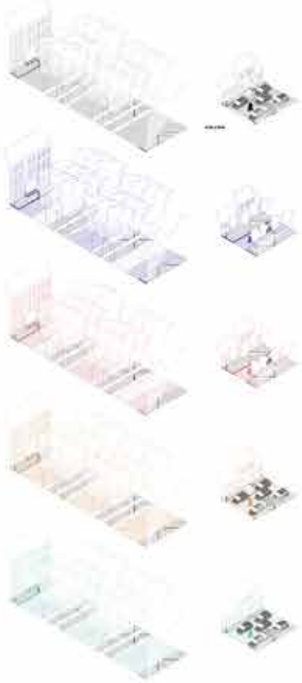
TRANSFORMATION POTENTIAL



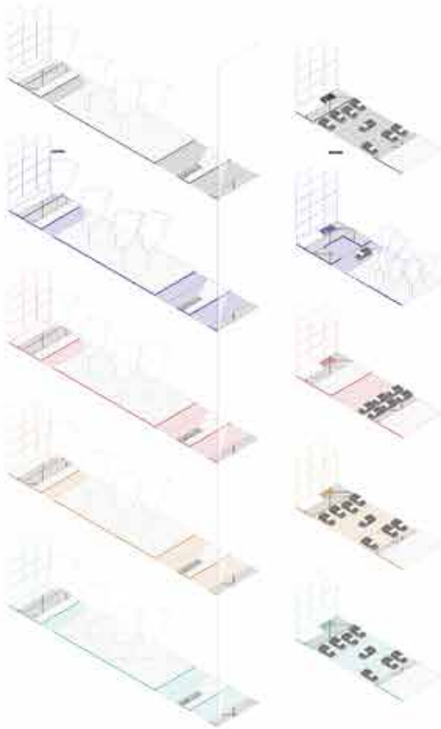
HWM1: CENTRE URBAN PLUS

HWM2: CENTRE URBAN

HWM3: CENTRE SMALL URBAN



HWM4: URBAN PRE-WAR

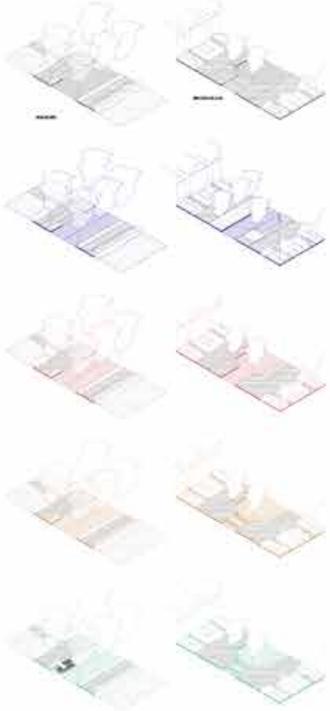


HWM5: URBAN POST-WAR COMPACT

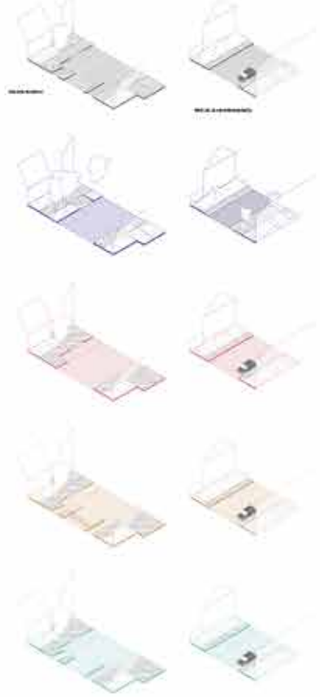
HWM6: URBAN POST-WAR LAND-BASED

HWM7: SMALL URBAN

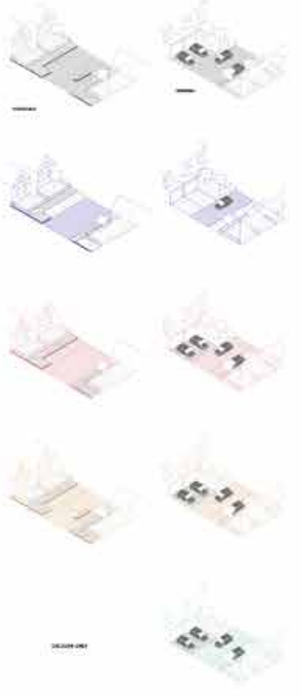
HWM8: GREEN-URBAN



HWM9: GREEN-SMALL-URBAN



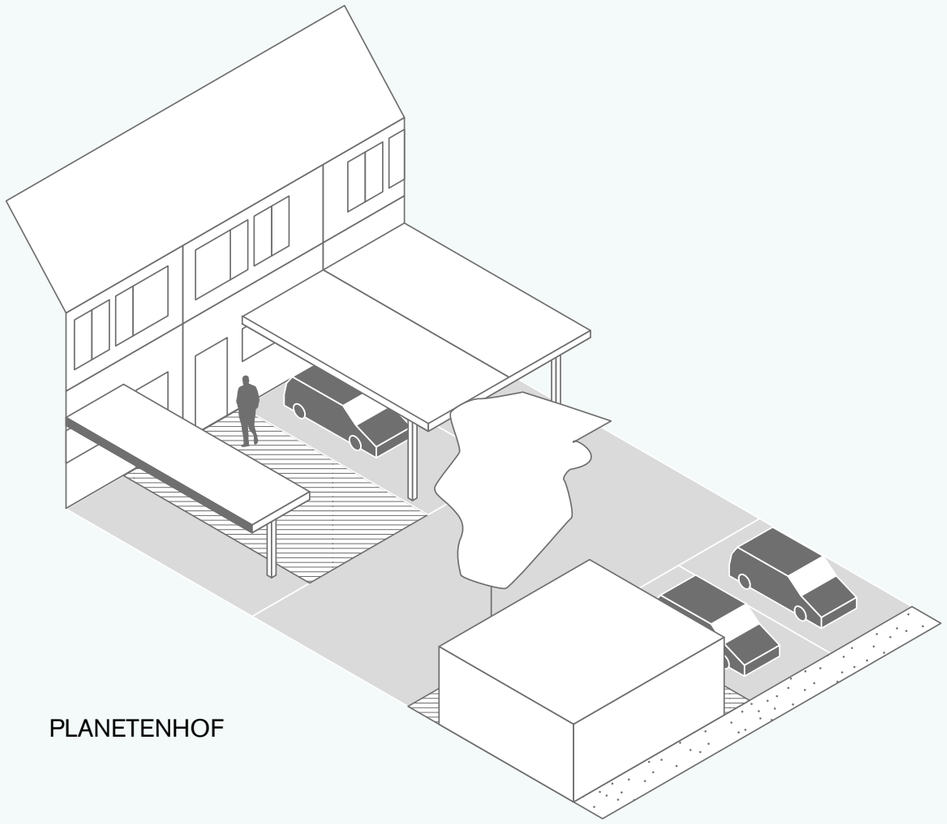
HWM10: CENTRE-VILLAGE



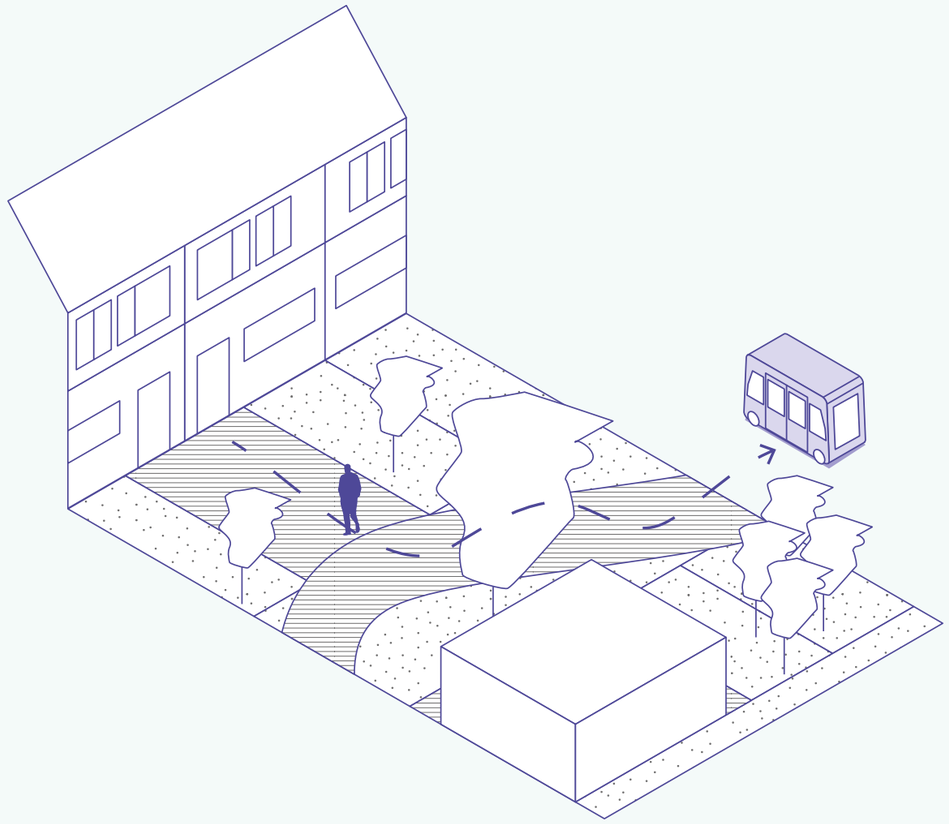
HWM11: VILLAGE

HWM12: RURAL

SMALL-URBAN (HWM7)



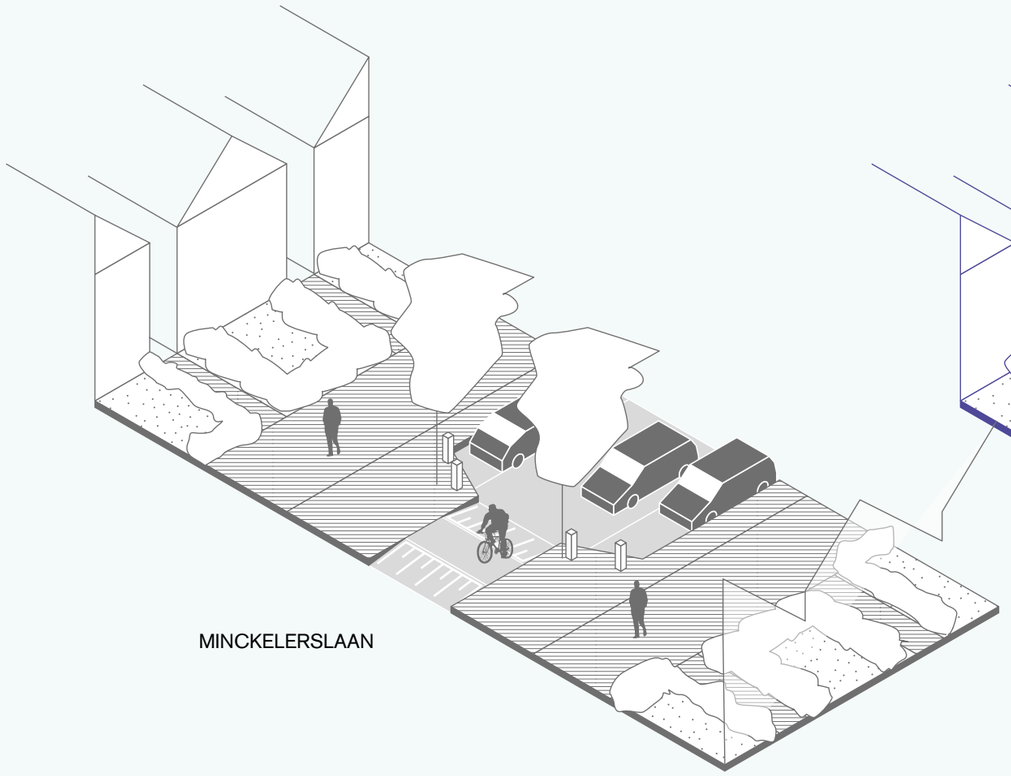
PLANETENHOF



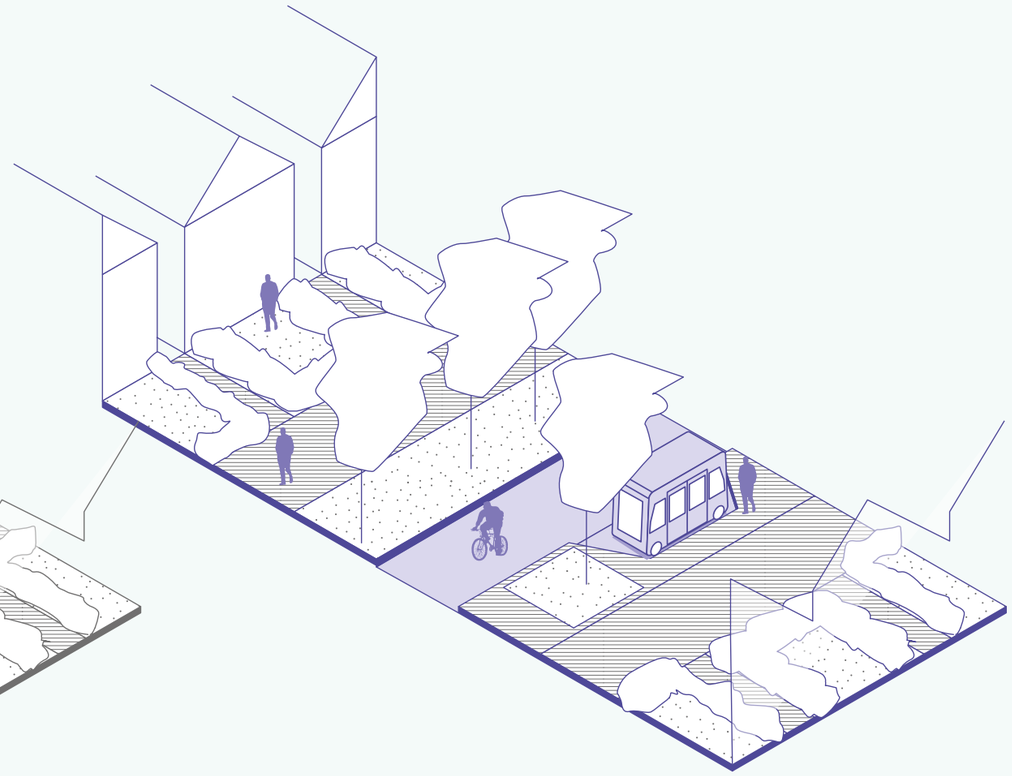
BASE

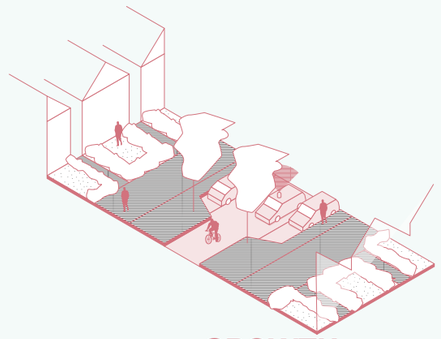
TRANSFORMATION

GREEN SMALL-URBAN (HWM9)

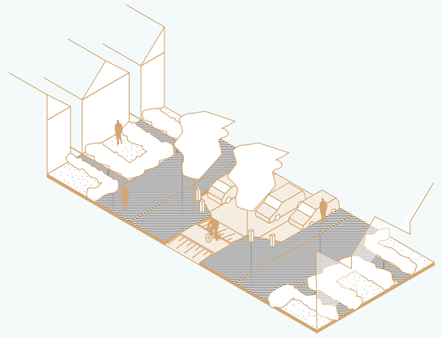


MINCKELERSLAAN

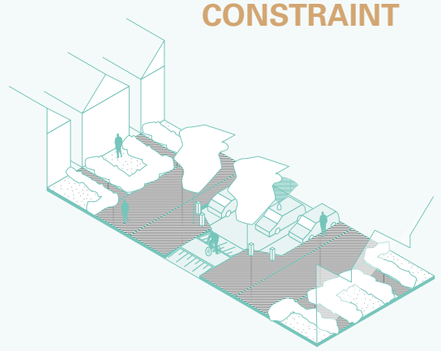




GROWTH



CONSTRAINT

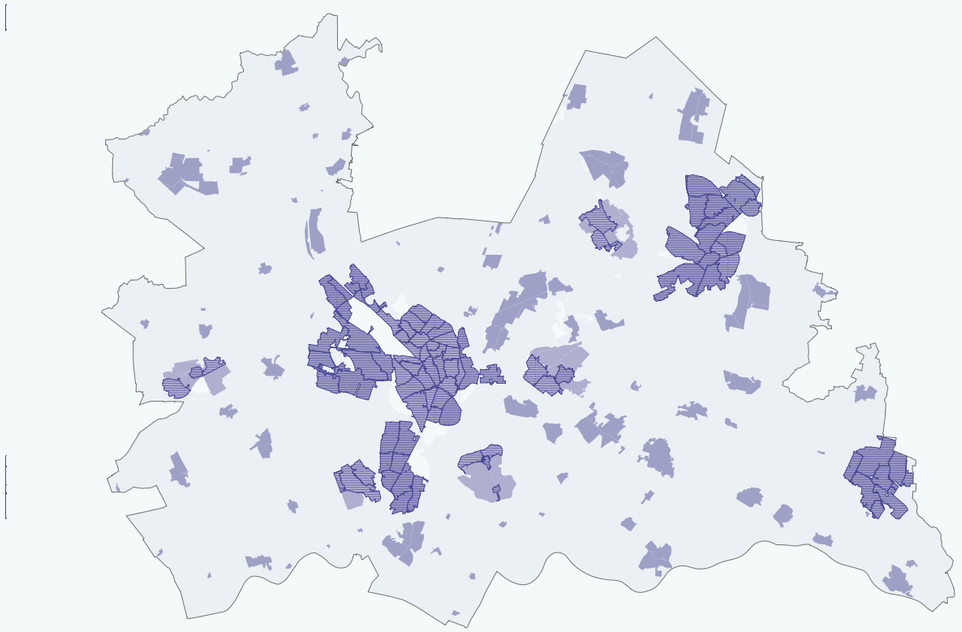


DECLINE

BASE

TRANSFORMATION

TRANSFORMATION



LEGEND

housing value premium

+5%

0

-5%

transformation potential

high

medium

low

CONSTRAINT

LEGEND

housing value premium

+5%

0

-5%

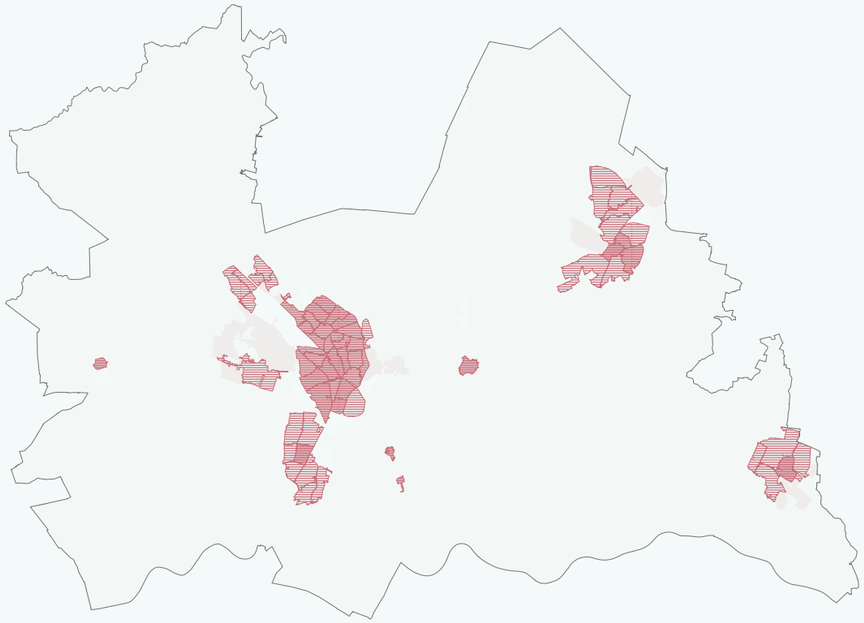
transformation potential

high

medium

low

GROWTH



LEGEND

housing value premium

+5%

0

-5%

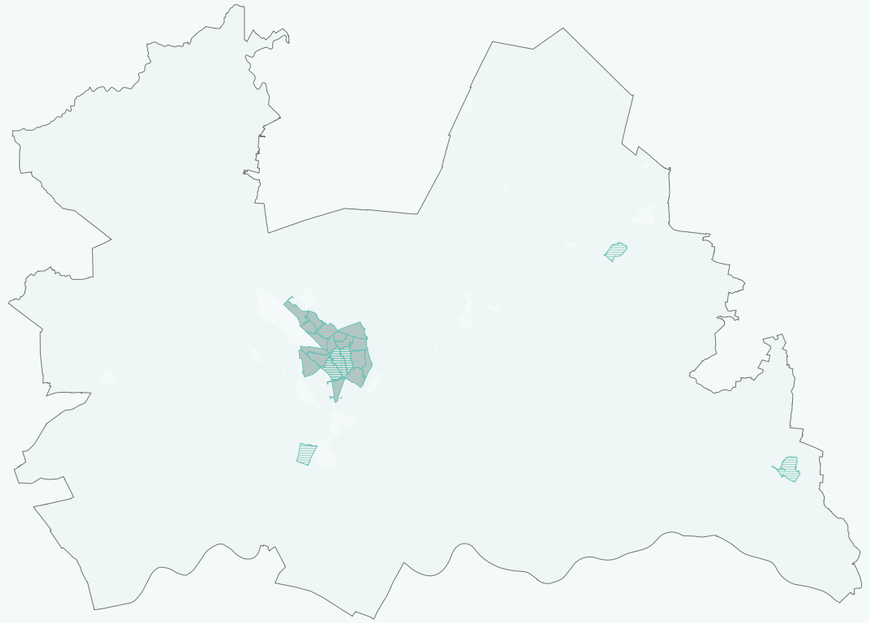
transformation potential

high

medium

low

DECLINE



LEGEND

housing value premium

+5%

0

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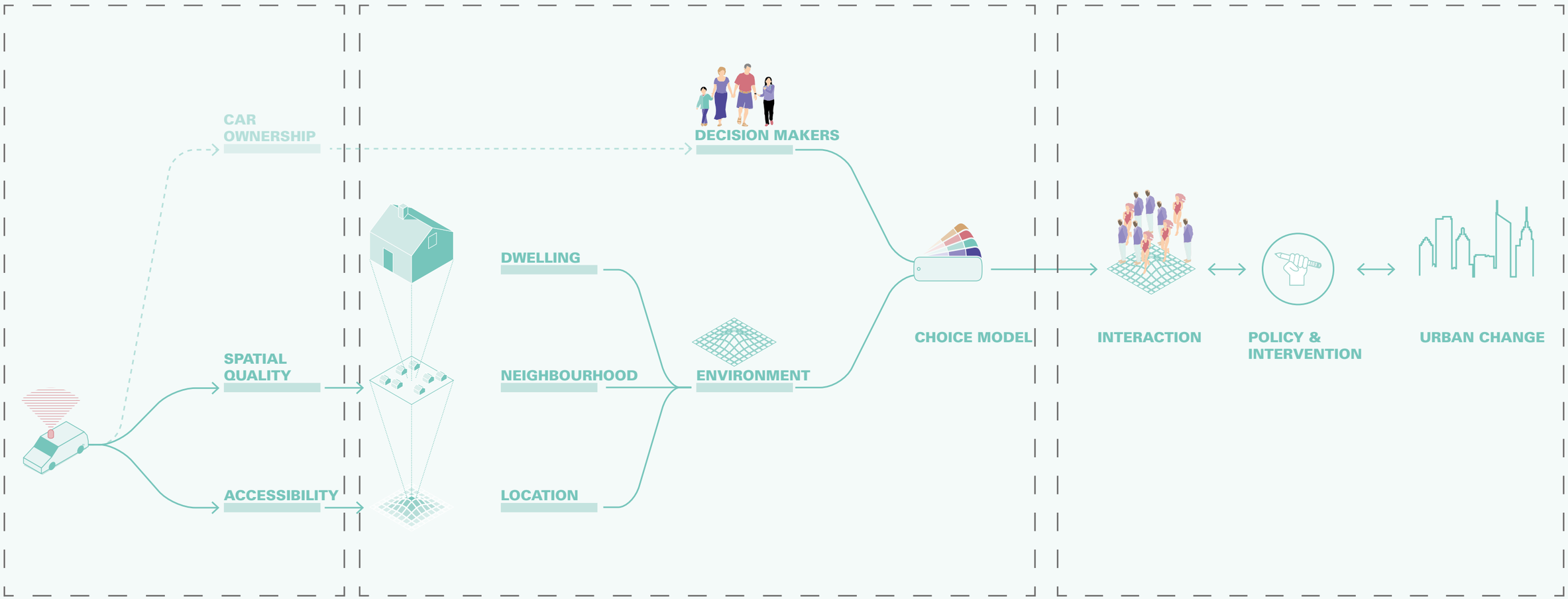
transformation potential

high

medium

low


CAR OWNERSHIP
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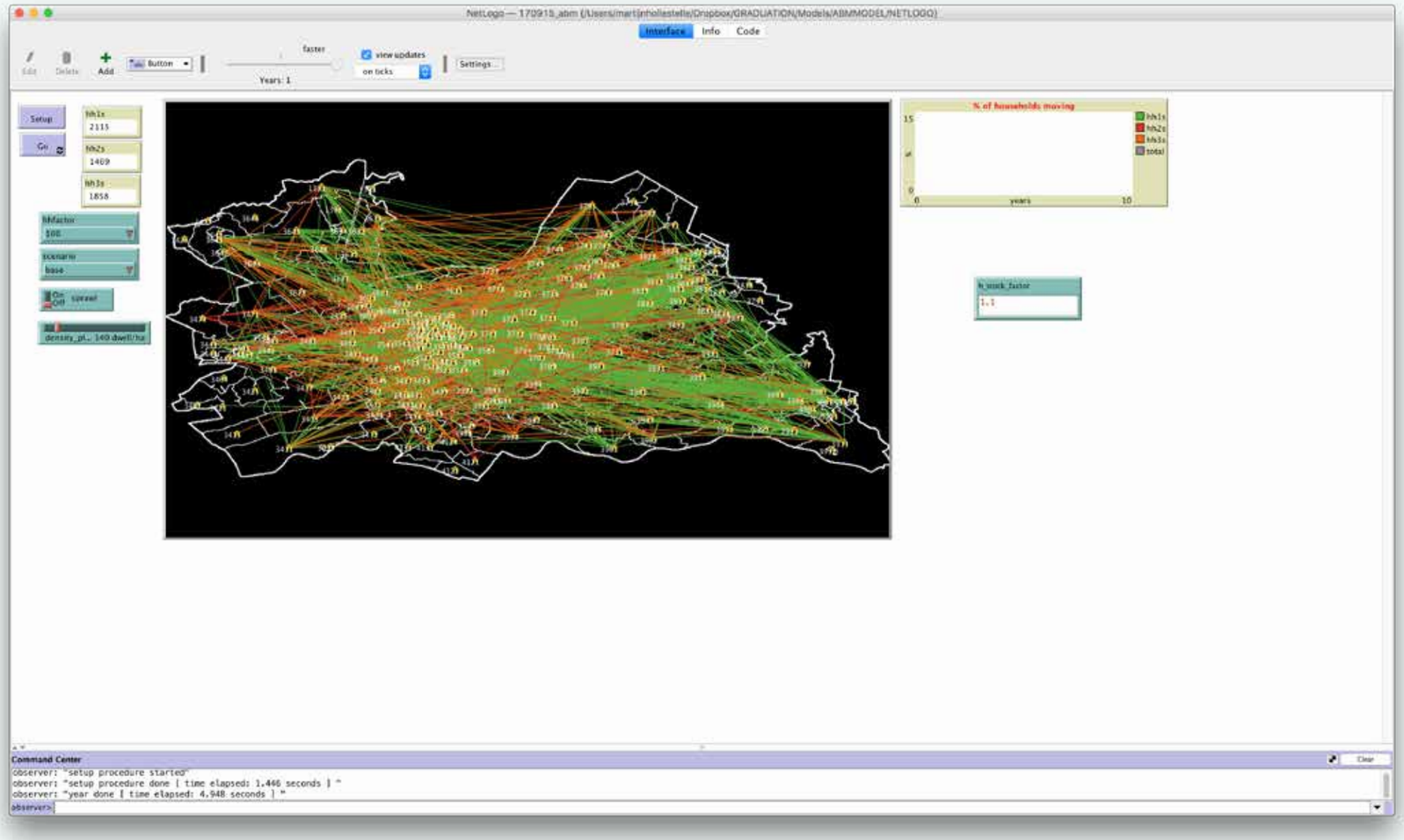
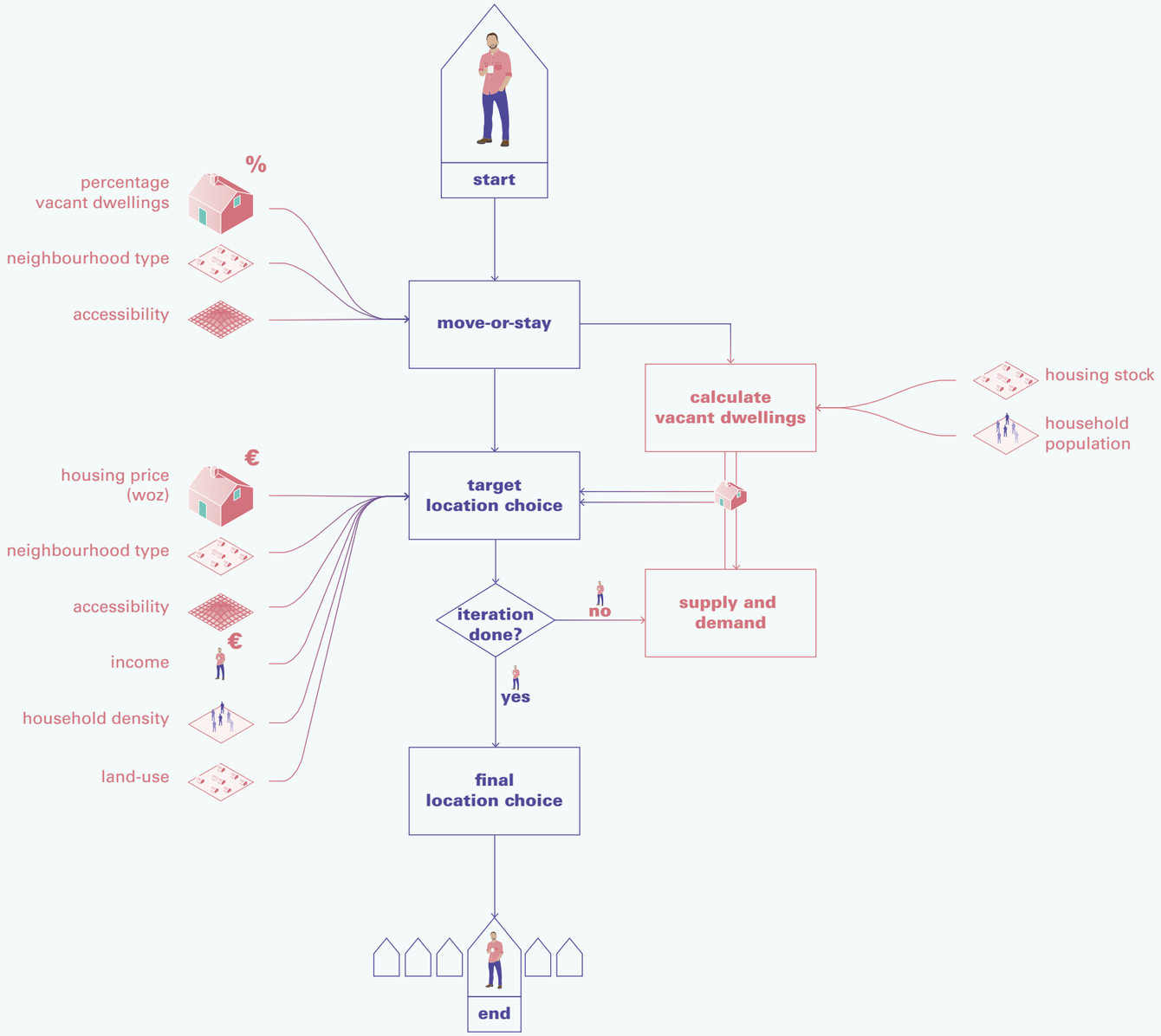
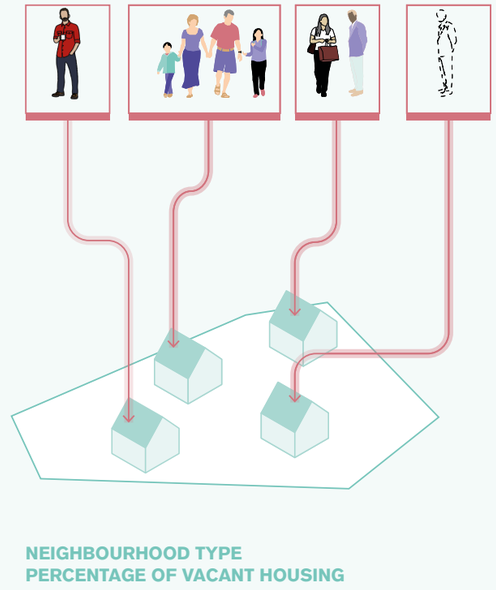
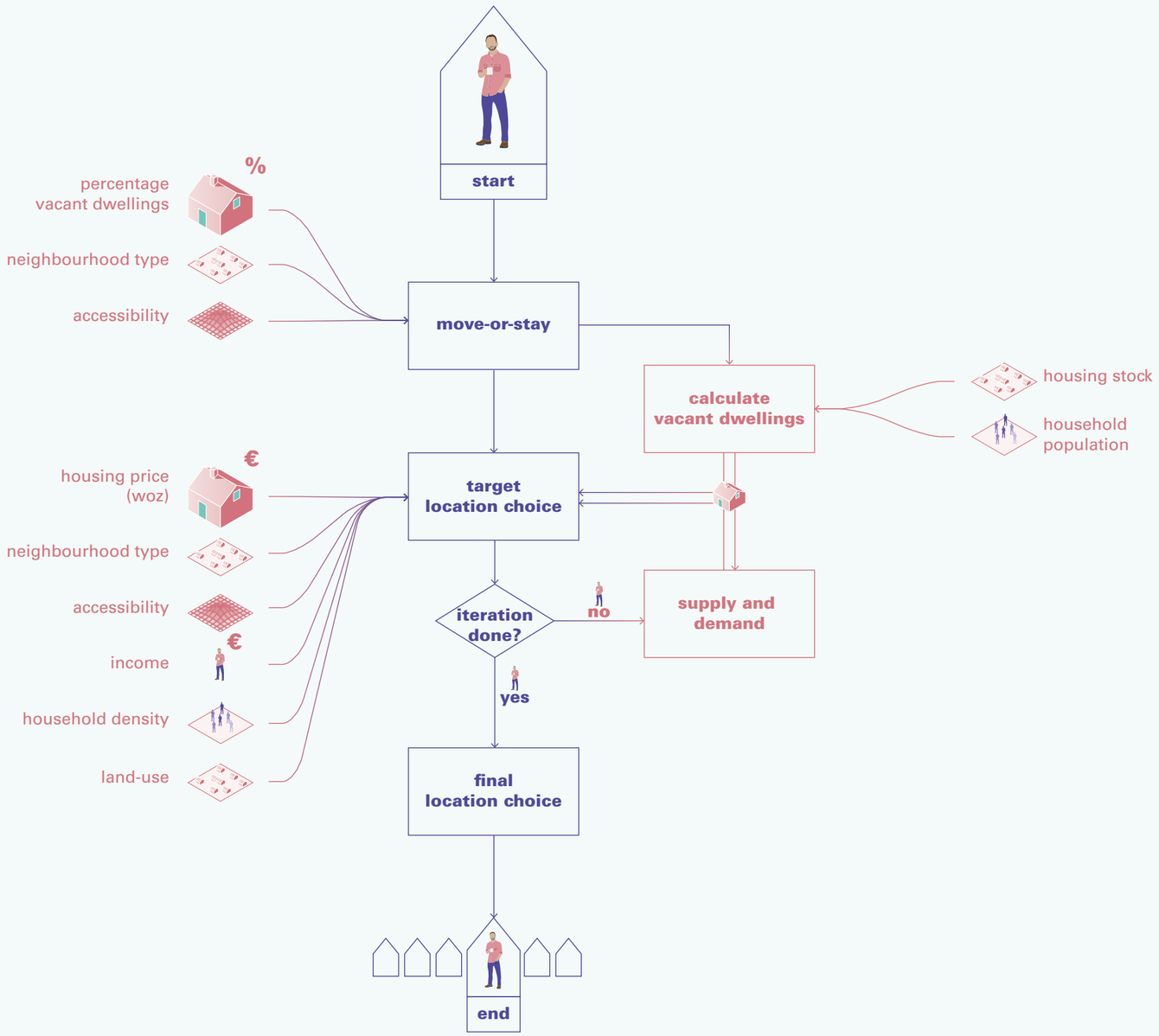
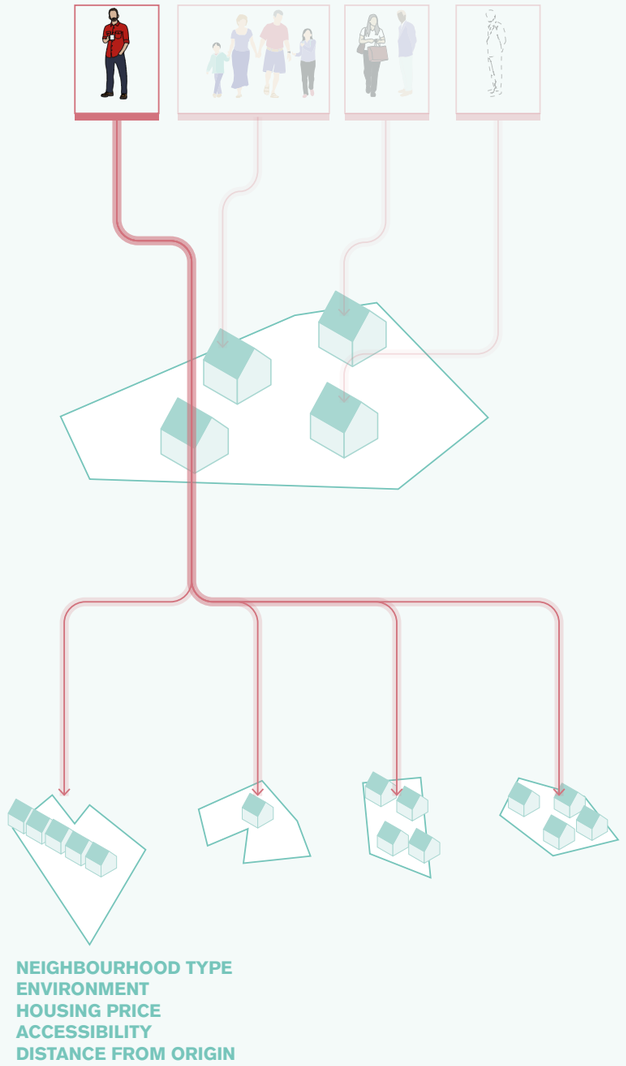
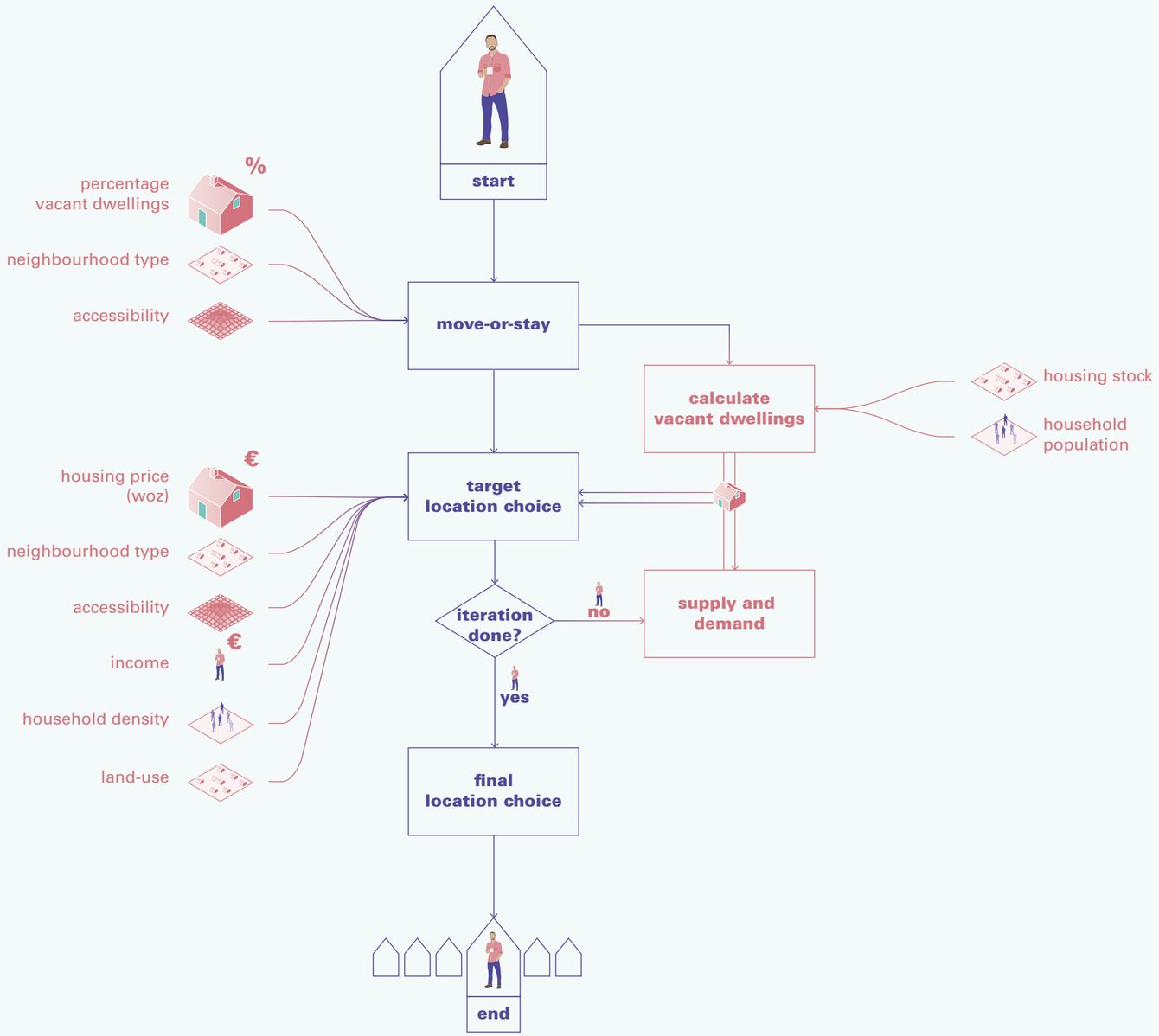

NetLogo — 170915_abm (/Users/mart/nhollestelle/Dropbox/GRADUATION/Models/ABMMODEL/NETLOGO)
Interface
Info
Code
Edit
Delete
Add
Button
faster
Years: 1
view updates
on ticks
Settings...
Setup
Go
hh1s
2115
hh2s
1469
hh3s
1858
hhfactor
100
scenario
base
spread
density_pl... 140 dwell/ha
% of households moving
15
0
0
years
10
hh1s
hh2s
hh3s
total
h_stock_factor
1.1
Command Center
Clear
observer: "setup procedure started"
observer: "setup procedure done [time elapsed: 1.446 seconds] "
observer: "year done [time elapsed: 4.948 seconds] "
observer>

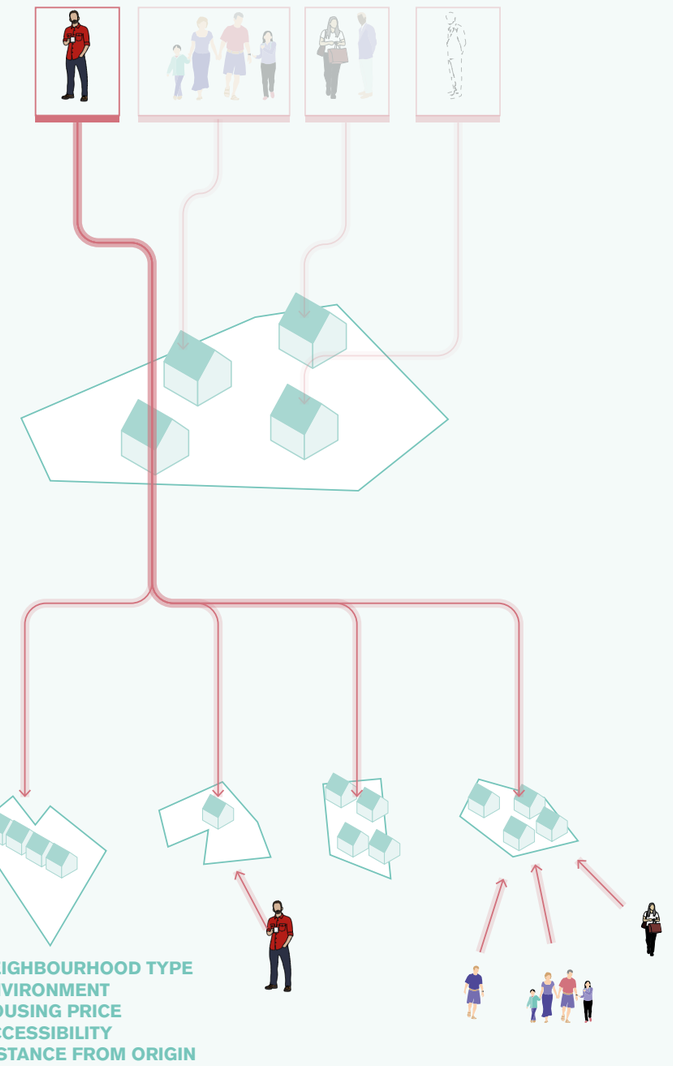

start
move-or-stay
percentage vacant dwellings
%
neighbourhood type
accessibility
calculate vacant dwellings
housing stock
household population
target location choice
housing price (woz)
€
neighbourhood type
accessibility
income
€
household density
land-use
iteration done?
no
supply and demand
yes
final location choice
end


NEIGHBOURHOOD TYPE
PERCENTAGE OF VACANT HOUSING


start
percentage vacant dwellings
%
neighbourhood type
accessibility
move-or-stay
calculate vacant dwellings
housing stock
household population
housing price (woz)
€
neighbourhood type
accessibility
income
€
household density
land-use
target location choice
iteration done?
no
supply and demand
yes
final location choice
end

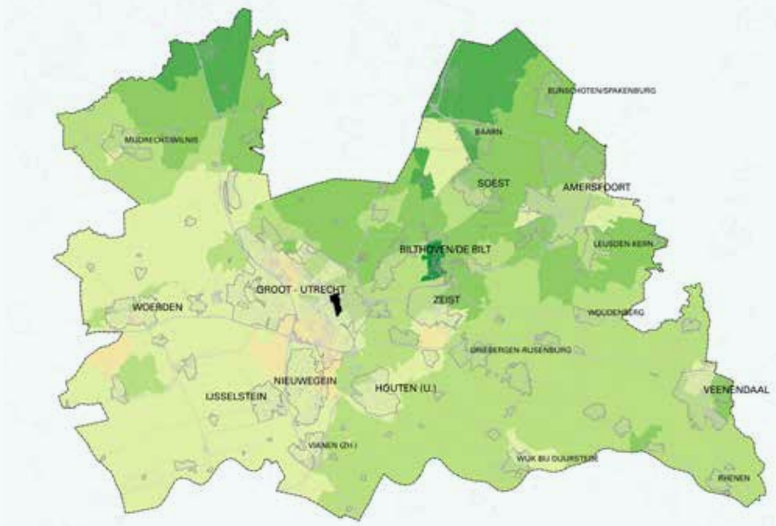

NEIGHBOURHOOD TYPE
ENVIRONMENT
HOUSING PRICE
ACCESSIBILITY
DISTANCE FROM ORIGIN


start
percentage vacant dwellings
%
neighbourhood type
accessibility
move-or-stay
calculate vacant dwellings
housing stock
household population
housing price (woz)
€
neighbourhood type
accessibility
income
€
household density
land-use
target location choice
iteration done?
no
supply and demand
yes
final location choice
end


NEIGHBOURHOOD TYPE
ENVIRONMENT
HOUSING PRICE
ACCESSIBILITY
DISTANCE FROM ORIGIN

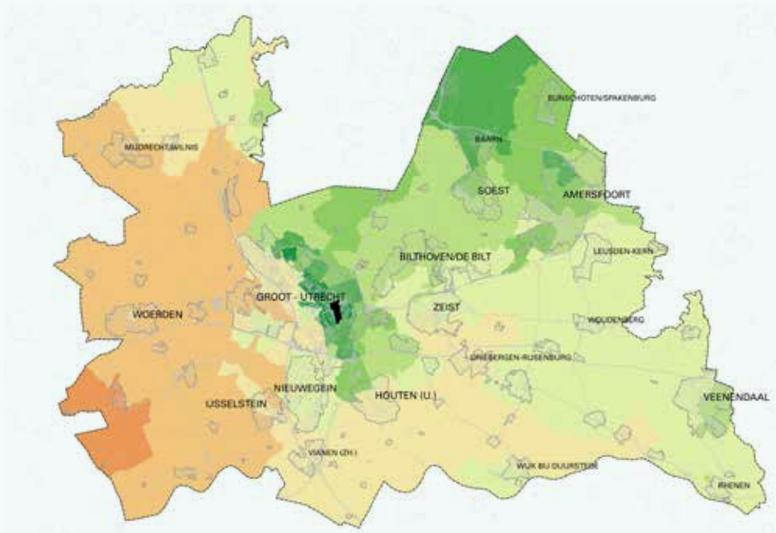
CHANGE IN ATTRACTIVITY FOR HOUSING

TRANSFORMATION

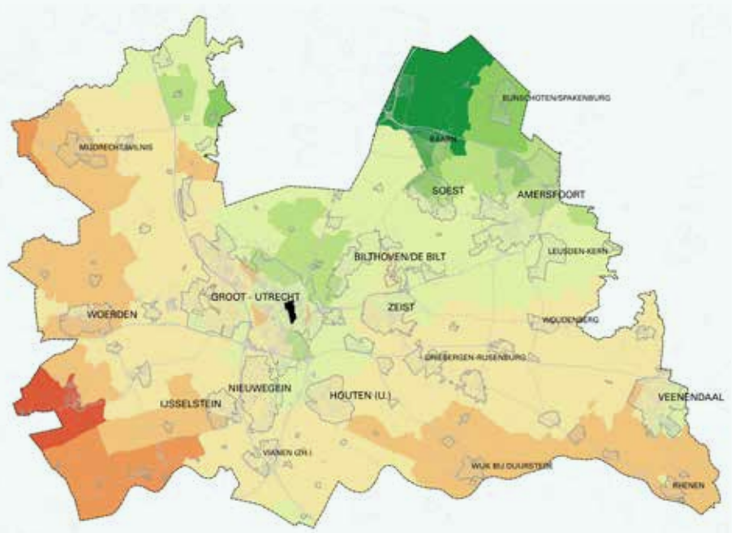


CONSTRAINT

GROWTH



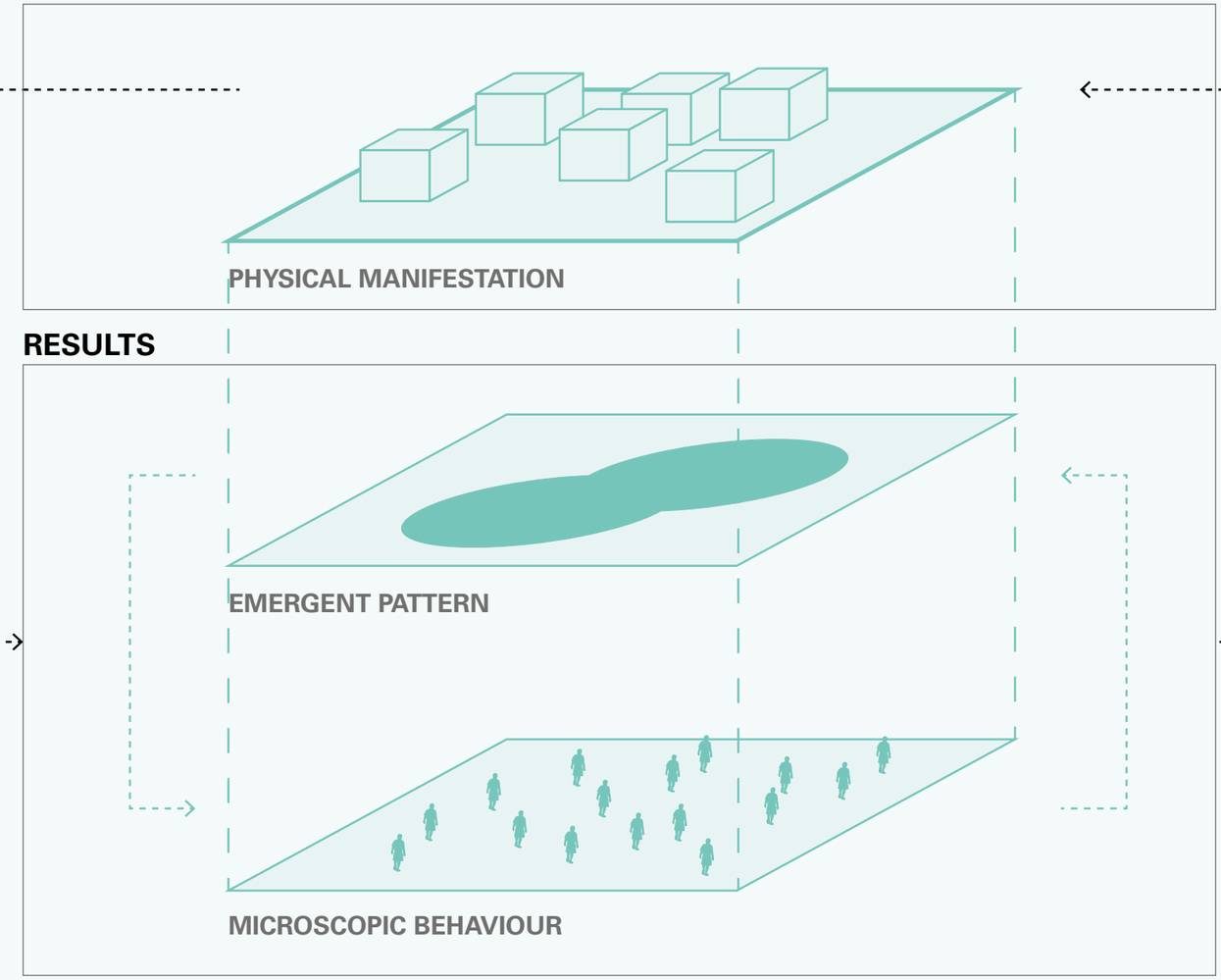
DECLINE



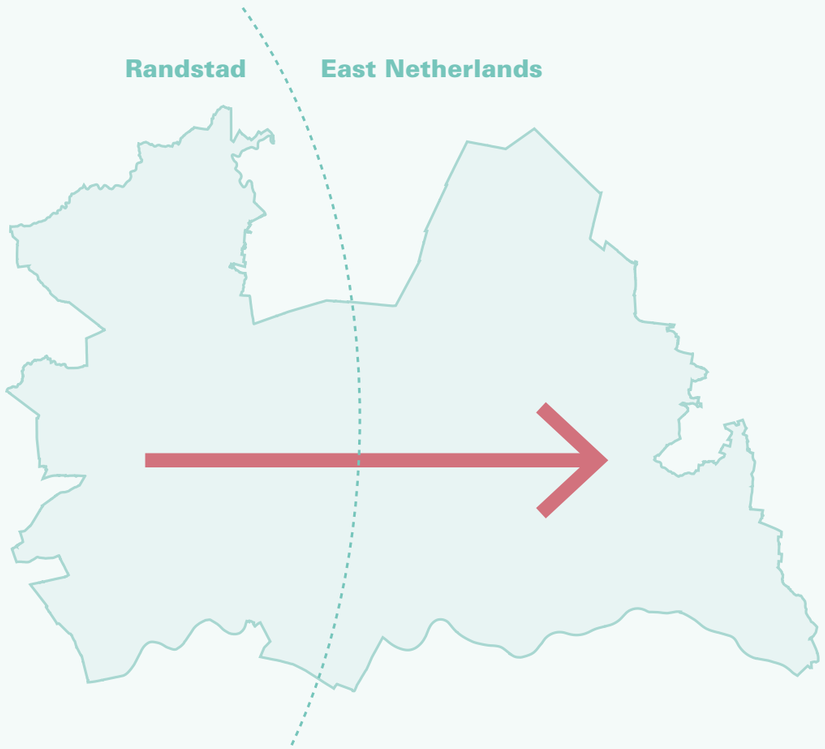
LEGEND

- < -20%
- -20% - -15%
- -15% - -10%
- -10% - -5%
- -5% - 0%
- 0% - +5%
- +5% - +10%
- +10% - +15%
- +15% - +20%
- > +20%

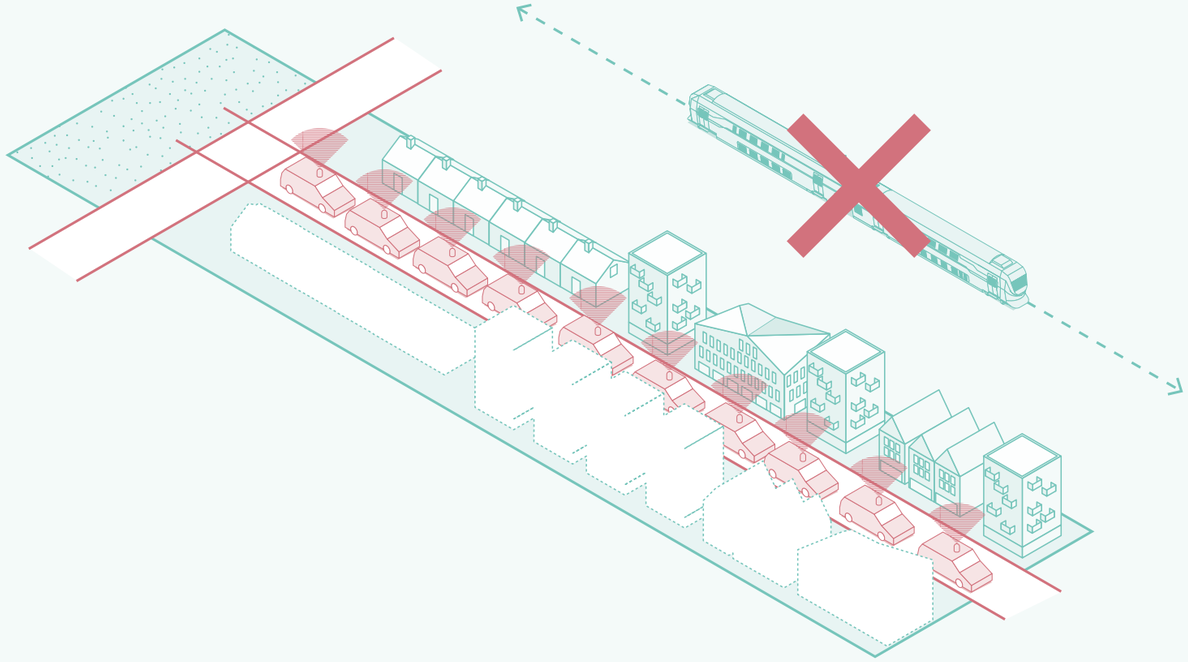
CONCLUSION

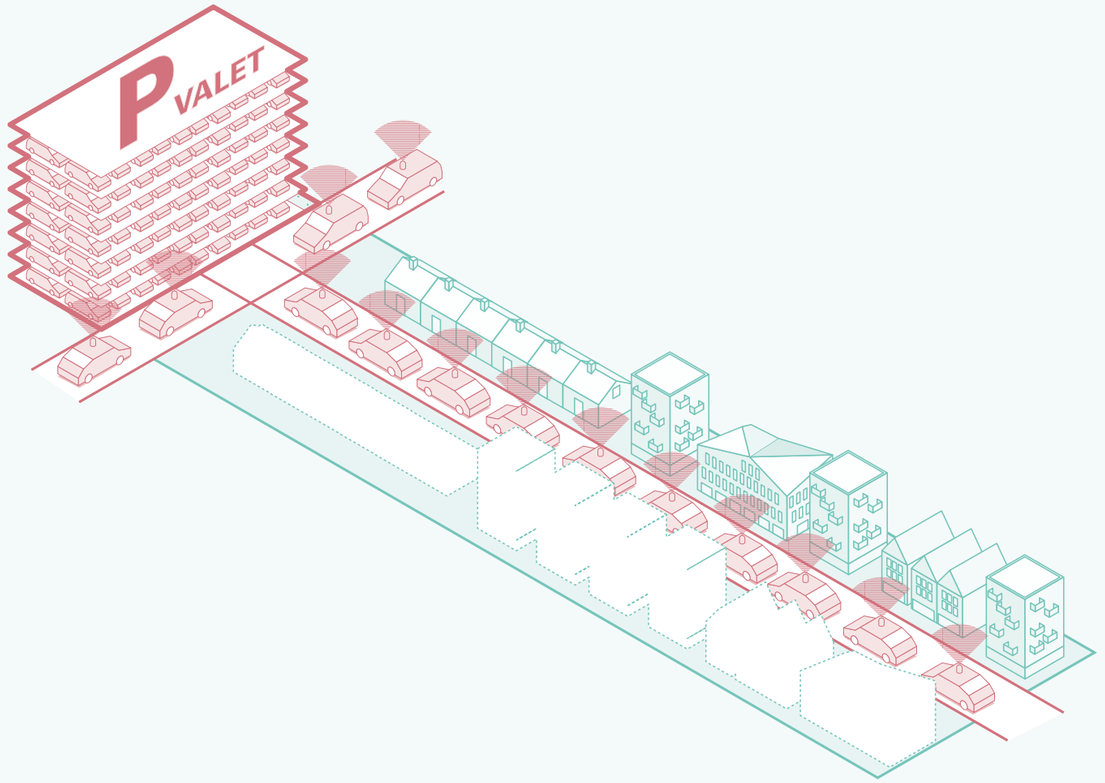

PHYSICAL MANIFESTATION
RESULTS
EMERGENT PATTERN
MICROSCOPIC BEHAVIOUR

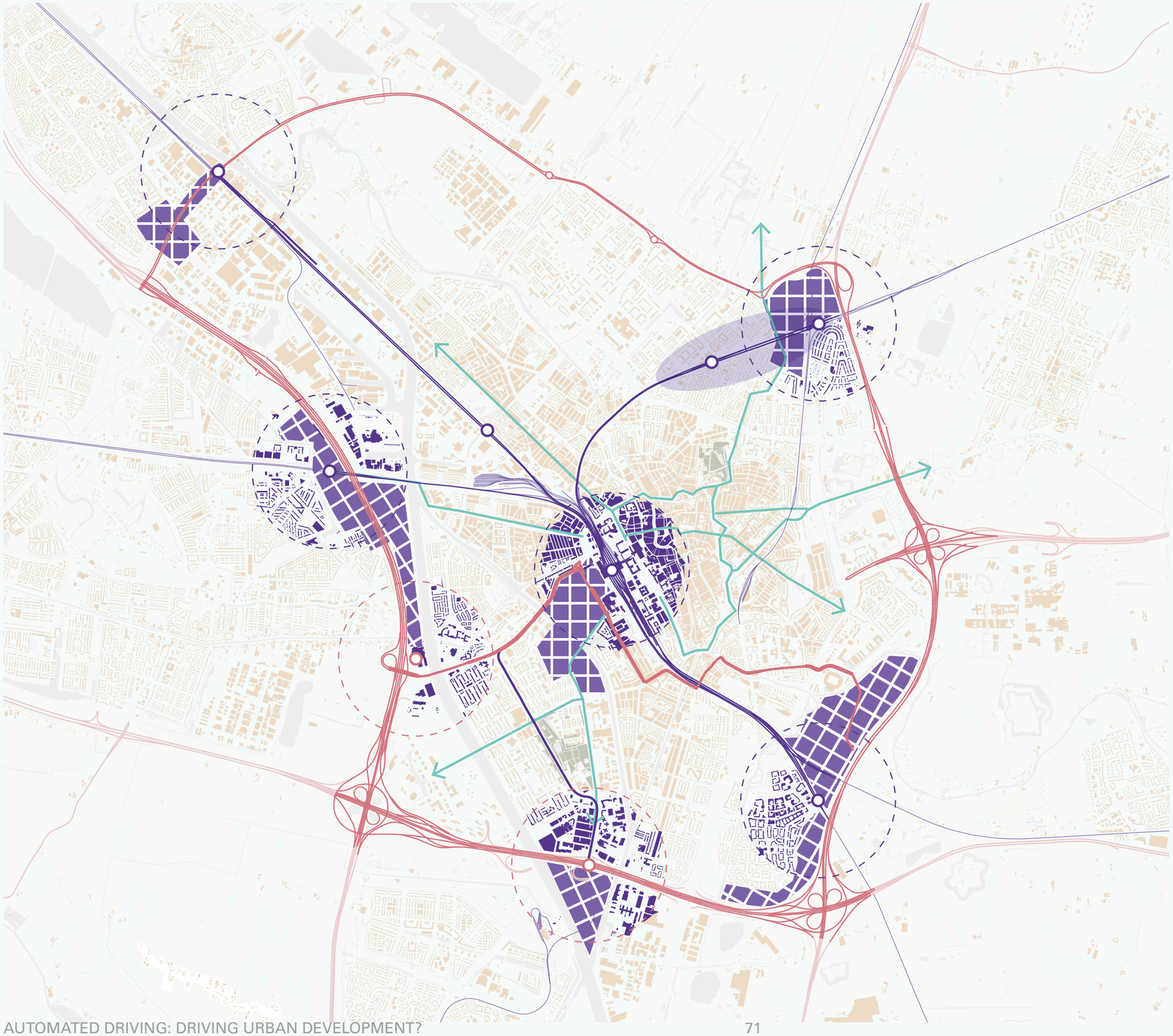
THE ASSIGNMENTS FOR AUTOMATED DRIVING



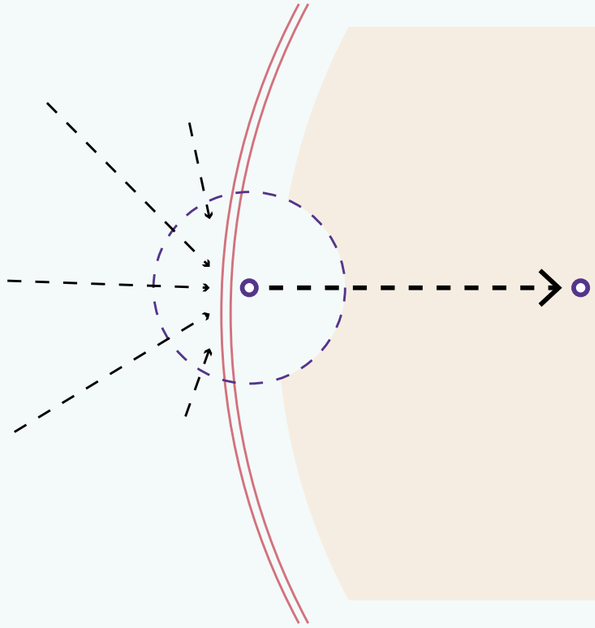
THE ASSIGNMENTS FOR AUTOMATED DRIVING



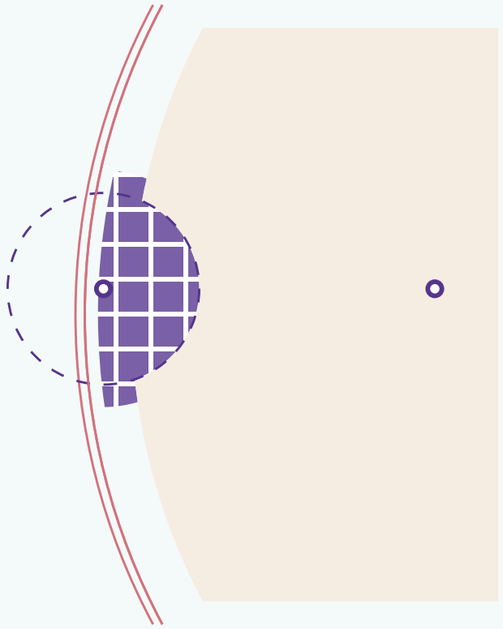



LEGEND
development node
programme development
main road connection
main rail connection
local street

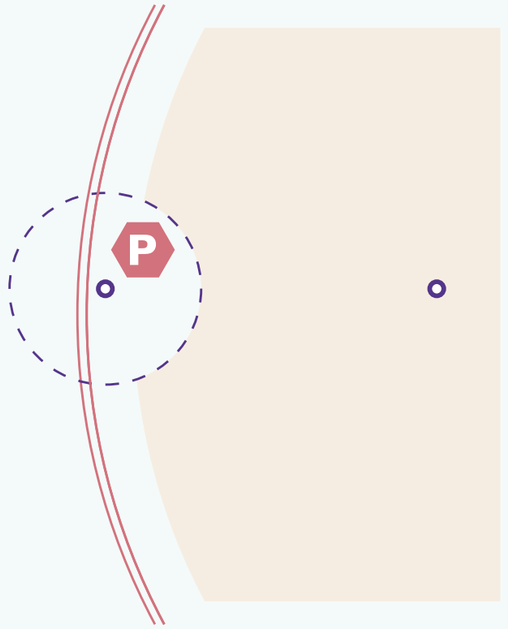
PRINCIPLES



nodes facilitate
clustering of flows



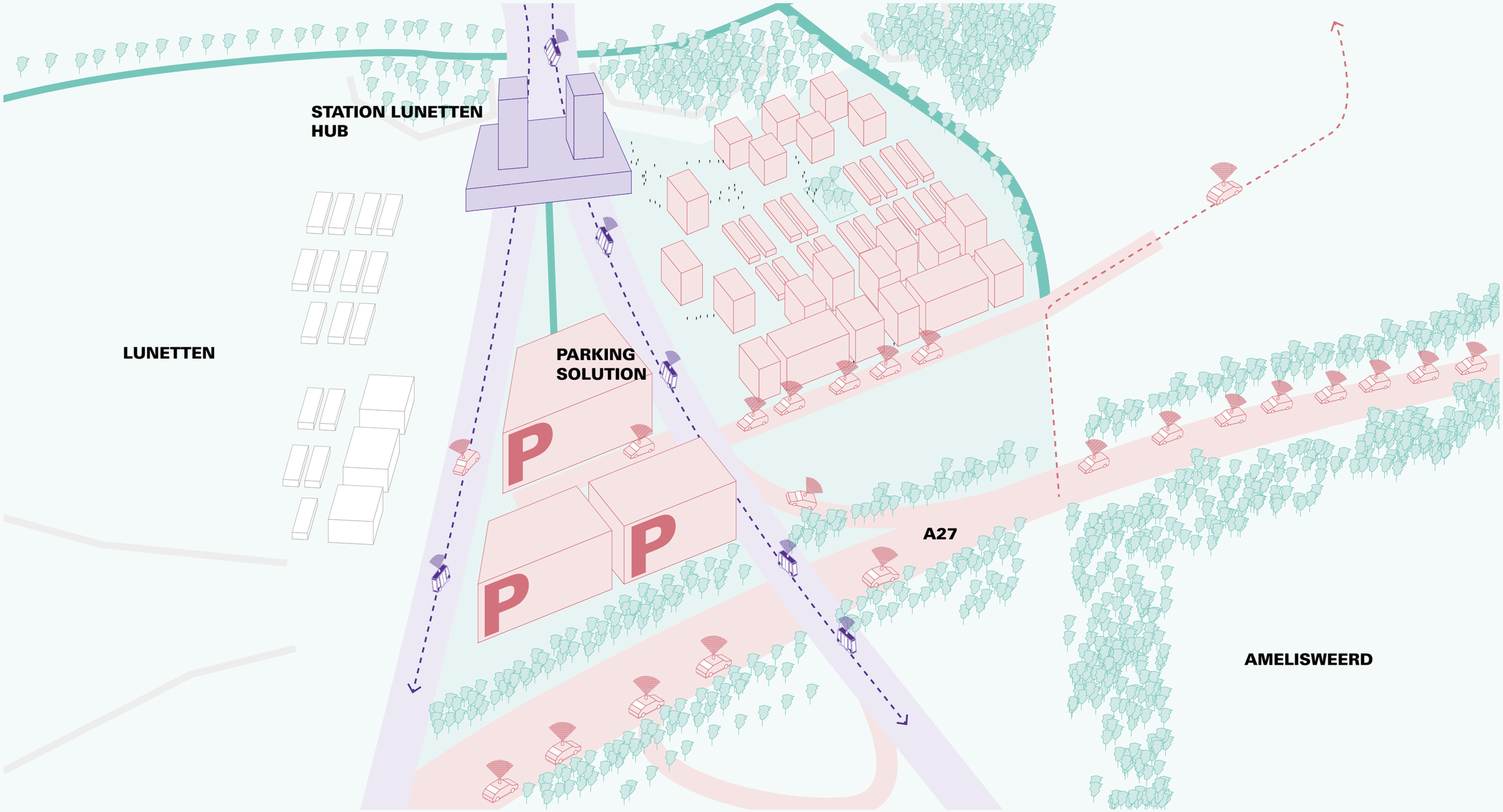
are an opportunity
for urban development



can provide for future
automated driving
developments

INTERVENTIONS

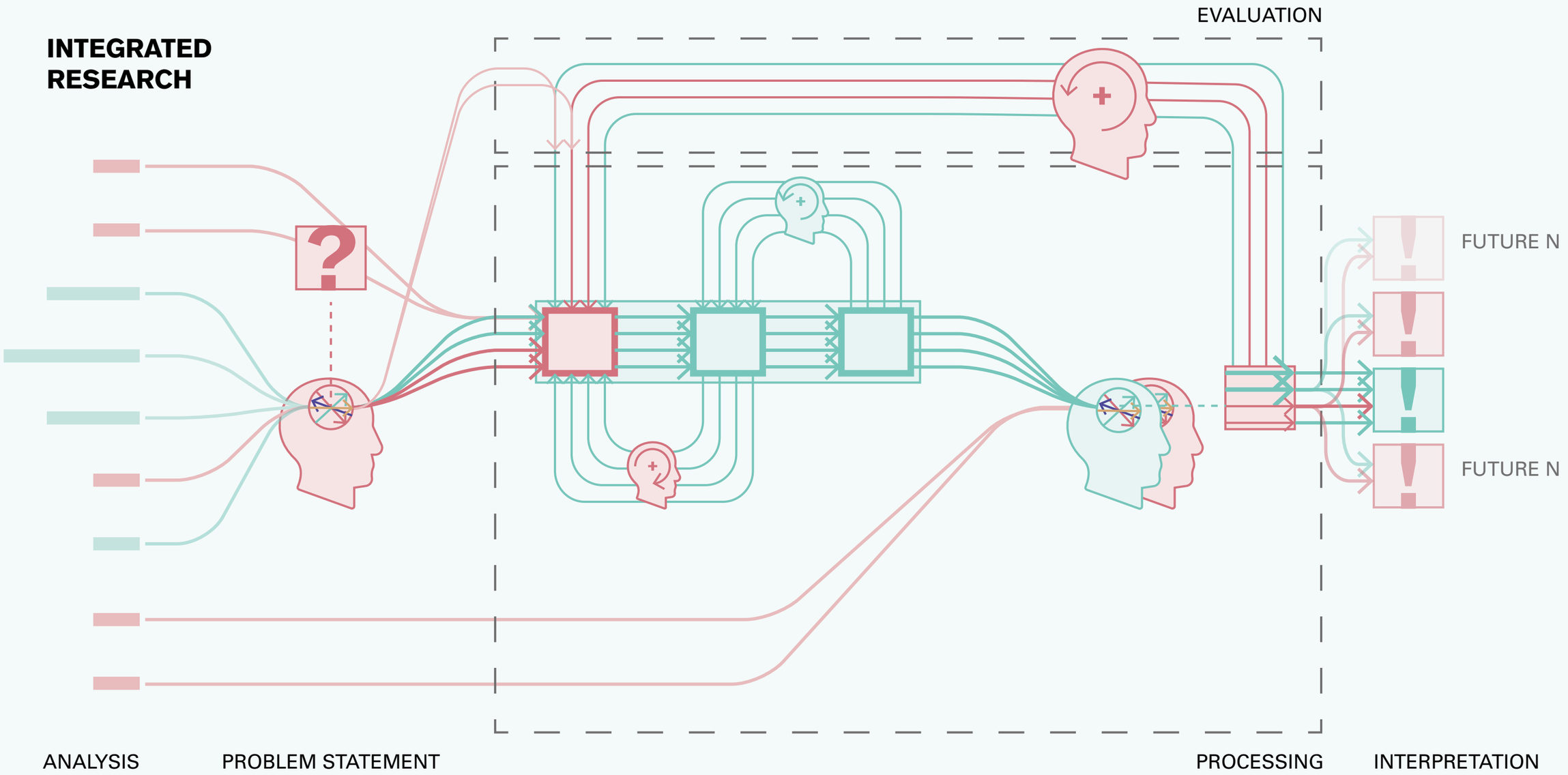
INTERVENTIONS



INTERVENTIONS

INTERVENTIONS

CONCLUSIONS



RECOMMENDATIONS

REFLECTIONS