

WUI-NITY architecture

Enrico Ronchi, Jonathan Wahlqvist

**Department of Fire Safety Engineering
Lund University, Sweden**

enrico.ronchi@brand.lth.se

WUI-NITY team



**Imperial College
London**



RESEARCH FOUNDATION
RESEARCH FOR THE NFPA MISSION



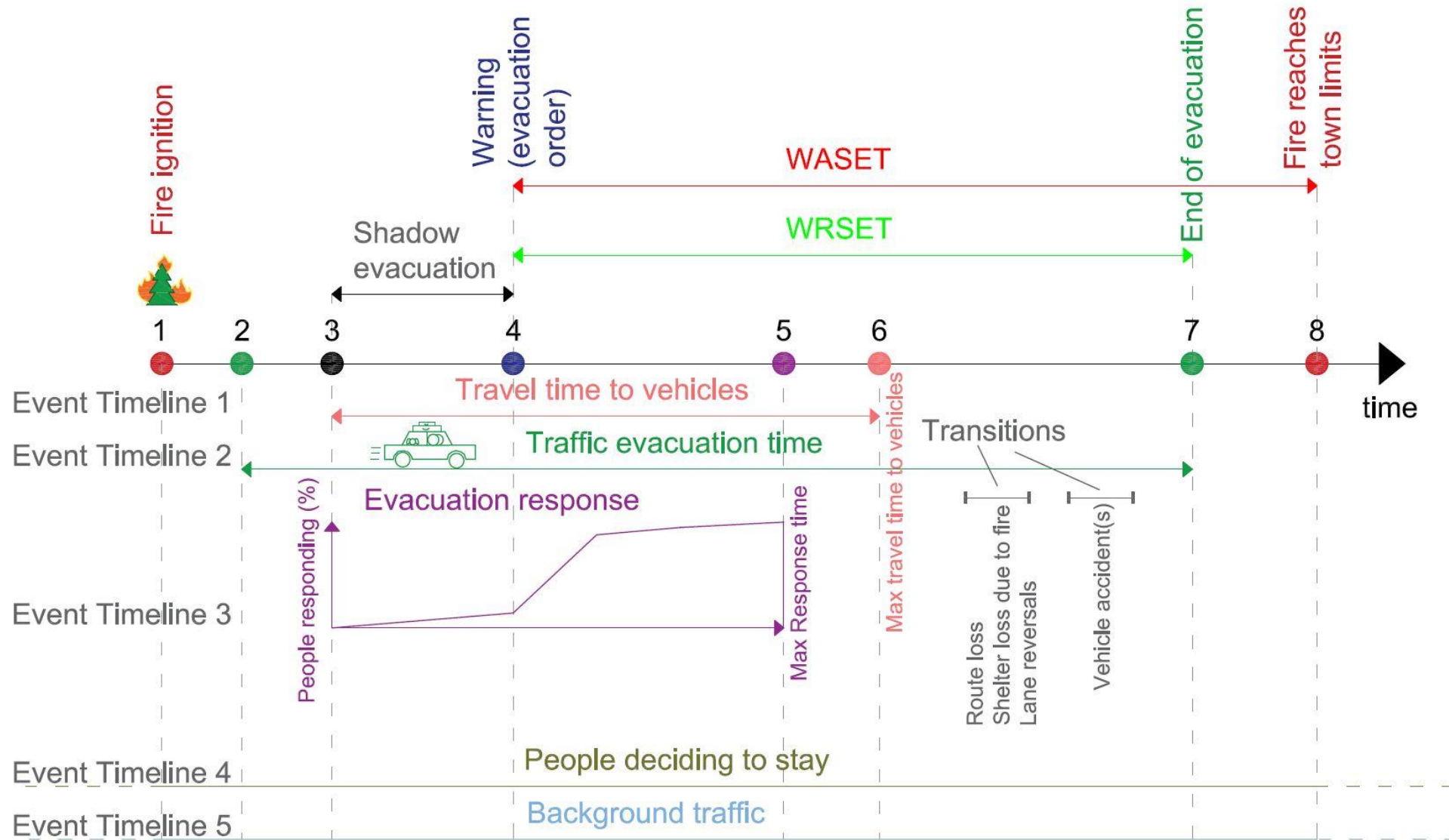
**LUND
UNIVERSITY**

Outline

- Conceptual modelling framework
- Implementation of architecture
- Inputs
- Simulation
- Outputs



Conceptual modelling framework



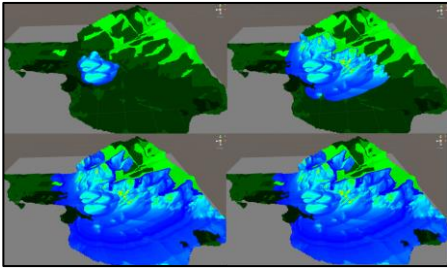
Conceptual modelling framework

- FARSITE outputs
- Custom CA model based on BEHAVE
- **FARSITE DLL to run through WUI-NITY (ongoing)**
- Prometheus (Imperial College) (ongoing)

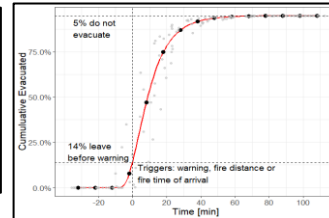
- Customizable human response curves
- Simple pedestrian movement to vehicles

- LWR / Greenshield model implementation, calibrated based on HCM
- Shortest/fastest/custom destinations
- **Additional traffic relationships (ongoing)**

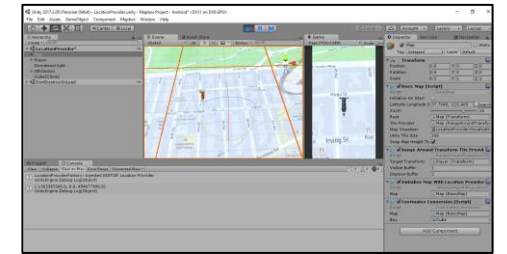
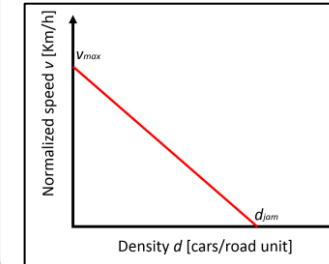
Fire



Pedestrian



Traffic



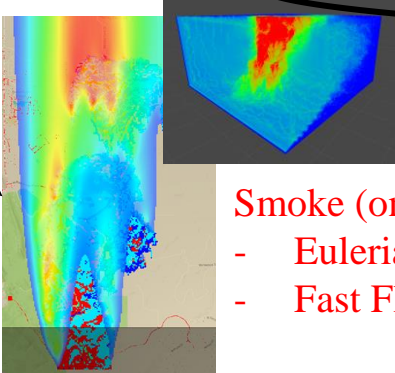
- Fire affects availability of destinations over time

Shelter capacity (ongoing)

Smoke (ongoing)

- Eulerian model
- Fast Fluid Dynamics

- **Smoke affecting traffic (ongoing)**



Implementation of architecture

Vocabulary

GameObject *is* used to represent anything which can exist in a scene

GameObjects are the building blocks for scenes in Unity, and act as a container for functional components which determine how the GameObject looks, and what the GameObject does

MonoBehaviour *is a script that can be attached to game objects in Unity (the entry point to the game Engine)*

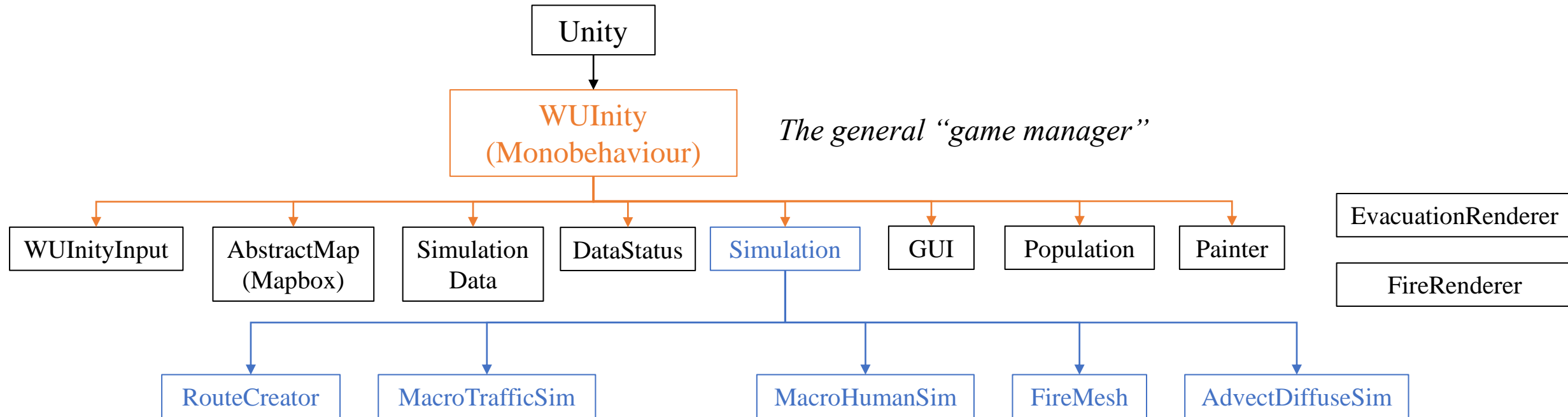
FORMAL DEFINITION

Game object is the base class for all entities in a Unity scene

MonoBehaviour is the base class from which every Unity script derives



Implementation of architecture



WUInityInput

General inputs

- Coordinates of the location of interest
- Time-step interval
- Visualization on/off
- Number of runs (for probabilistic applications, e.g., Monte Carlo methods)
- Size of computational domain
- Selection of models to be activated (fire, **smoke**, pedestrian, traffic)



WUInityInput

Inputs for Population

- GPW global database location
- Local GPW related to location of interest
- Population file location (for customization of e.g., # of people, people location)



WUInityInput

Inputs for human response modelling

- Household size
- Number of vehicles per household and other vehicle parameters
- Evacuation order
- General response curve
- Evacuation groups
- Events blocking destinations
- Household walking speed distribution
- Discretization of space for route choice



WUInityInput

Inputs for traffic modelling

- OpenStreetMap network / OSM data
- Evacuation Destinations
- Route choice preference (fastest, closest, custom)
- Minimum speed at capacity
- Background traffic density
- Change road type characteristics (e.g., for custom speed limits, lane reversal allowance)
- Traffic events (e.g., traffic accidents, lane reversal)
- Traffic injections
- Smoke impact on driving
- Choice of speed/density relationship



WUInityInput

Inputs for fire modelling within WUI-NITY

- .lcp (landscape) file location
- Fuel models file
- Ignition points
- Spread mode (4,8 or 24 neighbors)
- Weather information
- Wind data
- Initial fuel moisture
- Wind multiplier
- Random ignition map / points on/off
- Initial ignition map on/off

Inputs for reading FARSITE outputs

- Prefix to read FARSITE outputs
 - Time of arrival
 - Fireline intensity
 - Flame length
 - Rate of spread
 - Heat per area
 - Reaction intensity
 - Crown fire activity
 - Spread direction



WUInityInput

Other inputs

- Graphical inputs (e.g., spatial evacuation group definition, graphical fire inputs)
- Pre-calculated routing network database for traffic pathfinding
- Pre-calculated routes (O/D matrices)
- Optical density ramp



AbstractMap, SimulationData, DataStatus

AbstractMap

Used for visualization of the area of interest

Used for transformation between polar coordinates (latitude/longitude) to Unity space

SimulationData

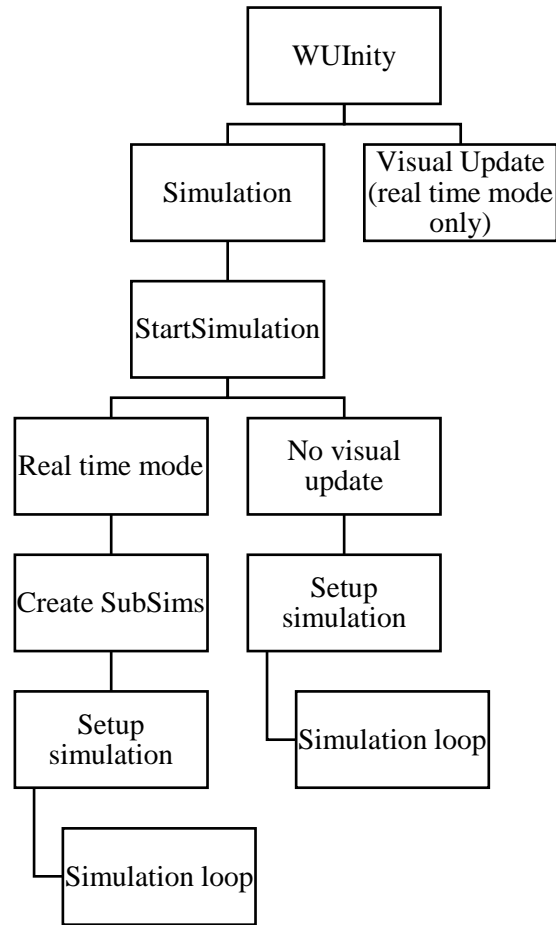
It creates and contains all run time data that gets built from user input

DataStatus

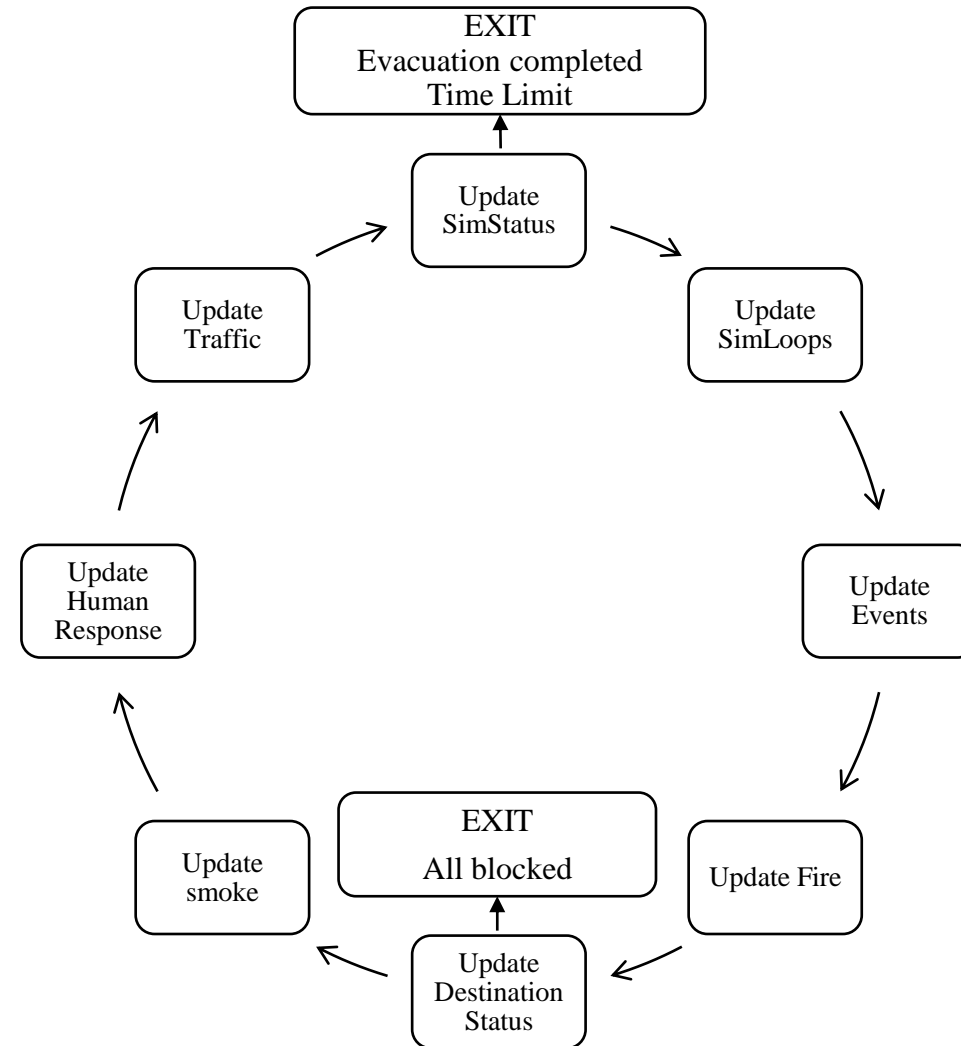
It verifies the SimulationData by keeping track of SimulationData status



Simulation



Simulation loop



Outputs (1 .csv for response and 1 .csv for traffic)

Response of households

- Households did not evacuate yet
- People did not evacuate yet
- Household started to move during time-step
- People started to move during time-step
- Households that reached vehicles during time-step
- People that reached vehicles during time-step
- Accumulated number of total vehicles activated
- Floating average walked distance to vehicle

*Additional outputs are
only for visualization
currently*

Traffic

- Number of injected vehicles on the road during time-step
- Number of vehicles that reached destination during time-step
- Total vehicles currently in the system
- Number of people reaching destination during time-step
- Average velocity of active vehicles
- Minimum velocity of active vehicles
- Accumulated number of people at destinations
- Flow at destinations

