resilience.io

technical specification (abbreviated)

The systems model that underpins **resilience.io** will spatially represent a city, its supply hinterland and its connections at global scale, to model how resource use can be transformed to be more efficient and sustainable with environmental and social value incorporated along side economic values. The flexible model architecture provides the ability for coding expansion and adaptation to iteratively improve the representation of any city-region context. The architecture will be structured through the development of 26 software components which fall under 5 main descriptive headings, these are:

1 - Software engine components

- **Command line simulation** - the command line interface for the model and data files
- **Temporal clock execution** - the tracking of processes occurring in time
- **Database environments** - the tables capturing all data and properties
- **Model testing engine** - the testing and validation including uncertainty analysis, accounting and plausibility tests

2 - Initialization components

These components provide an outline of the sets of resources, human and natural infrastructures, existing process/technology resource conversions, and population and company agents. This initialization step utilizes all collected datasets, translates these into the initial model data, and links appropriate objects to each other; the components are:

- **Space generation** - the spatial map of a city region and its supply hinterland
- **Land use allocation** - relevant spatialised land use categories and data
- **Exogenous demand datasets** - initial city region demand datasets
- **Agent clusters setup** - the datasets interlinking agent actors and their attributes
- **Entity assignments** - all entities e.g. infrastructure, materials and natural entities
- **Process to entity allocation** - resource conversion processes to entities allocation
- **Agent spatial allocation** - the setup of agents within the spatialised city region

3 - Short time step components

Short time step components (daily, weekly or monthly) resolve resource flows based on the current structure of an economy and its resources. The economic to resource to environment linkages in the model, are built on the basis of physical flows, on top of which economics such as markets, exchange and financial flows are built. The operation of these short-term fluxes are simulated to provide spatial and temporal operation of processes and agent decisions through the following components:

- **Process operations** - input-output relations and energy and labour input drivers, resulting in change.
- **Transport process** - physical linkage between input demands and outputs provided
- **Weather patterns** - basic weather patterns used to simulate seasonal changes in activity patterns
- **Population agent activities and demands** - simulation of activities and resource consumption of the population
- **Market exchange and price development** - market exchange of produced goods over time
- **Company agent demands** - to simulate the demands on a company level
- **Process decisions** - simulation of decisions of agents that affect process operation
- **Agent cluster change** - change in the number of population and company numbers

4 - Long time step components

The short-term components do not provide for change in the human ecosystem. This will be addressed by the following long time step components (quarterly or annually):

- **Demographics, household, and education** - change in age, births, deaths, composition of households and education
- **Infrastructure ownership** - the inclusion of ownership of sector entities and their related process outputs
- **Workforce and employment development** - due to investment scenarios based on savings and new sector entities

5 - User decision components

Lastly, one of the key purposes of developing the platform is to understand how different policy, planning, and technology investment decisions affect a city region. Sets of user decisions provide the ability to test variations in policy and scenario outcomes, and the interpretation of these outcomes form a set of key performance indicators. This functionality is included within the following components:

- **External world scenarios** - the integration of trade variation with the outside world and links to global climate models
- **Decision Interventions** - a set of user driven policy, planning, and technology/infrastructure investment decision options
- **Key Performance Indicators** - a series of summary indicators within environmental, economic and social dimensions

These components will be programmed through the combination of the following tools based on our open source approach:

GNU Linear programming kit - used as the optimisation solver
YAML - data management architecture
Eclipse IDE - used as the integrated development environment
Repast Simphony + SmartCityModel – used for the Agent-Based Model Components