NavIndoor: System Description - IPIN 2016

Track 1 "Smartphone-based" &
Track 3 "Smartphone-based (off-site)"

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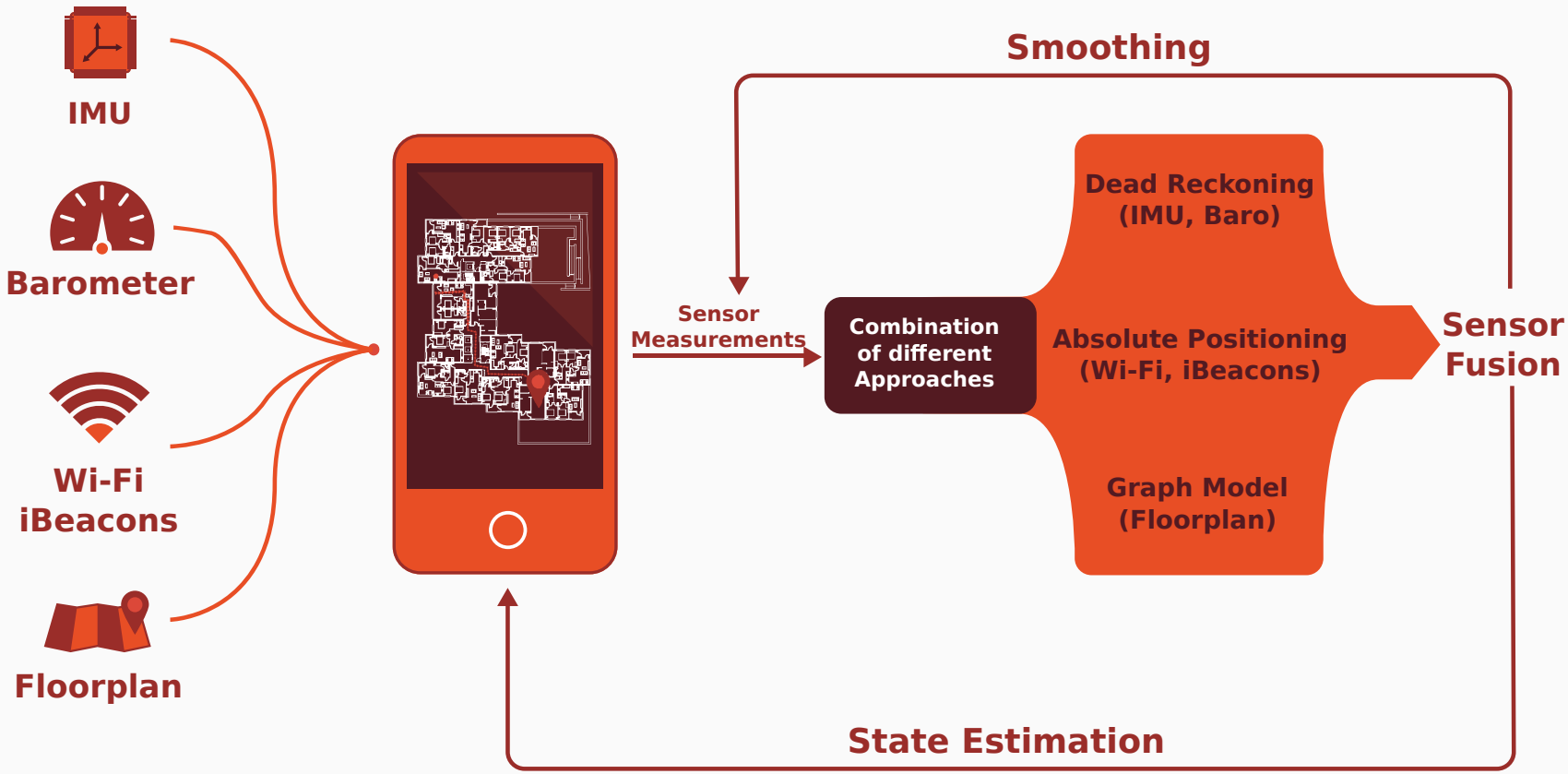
Indoor Localisation System



Observation

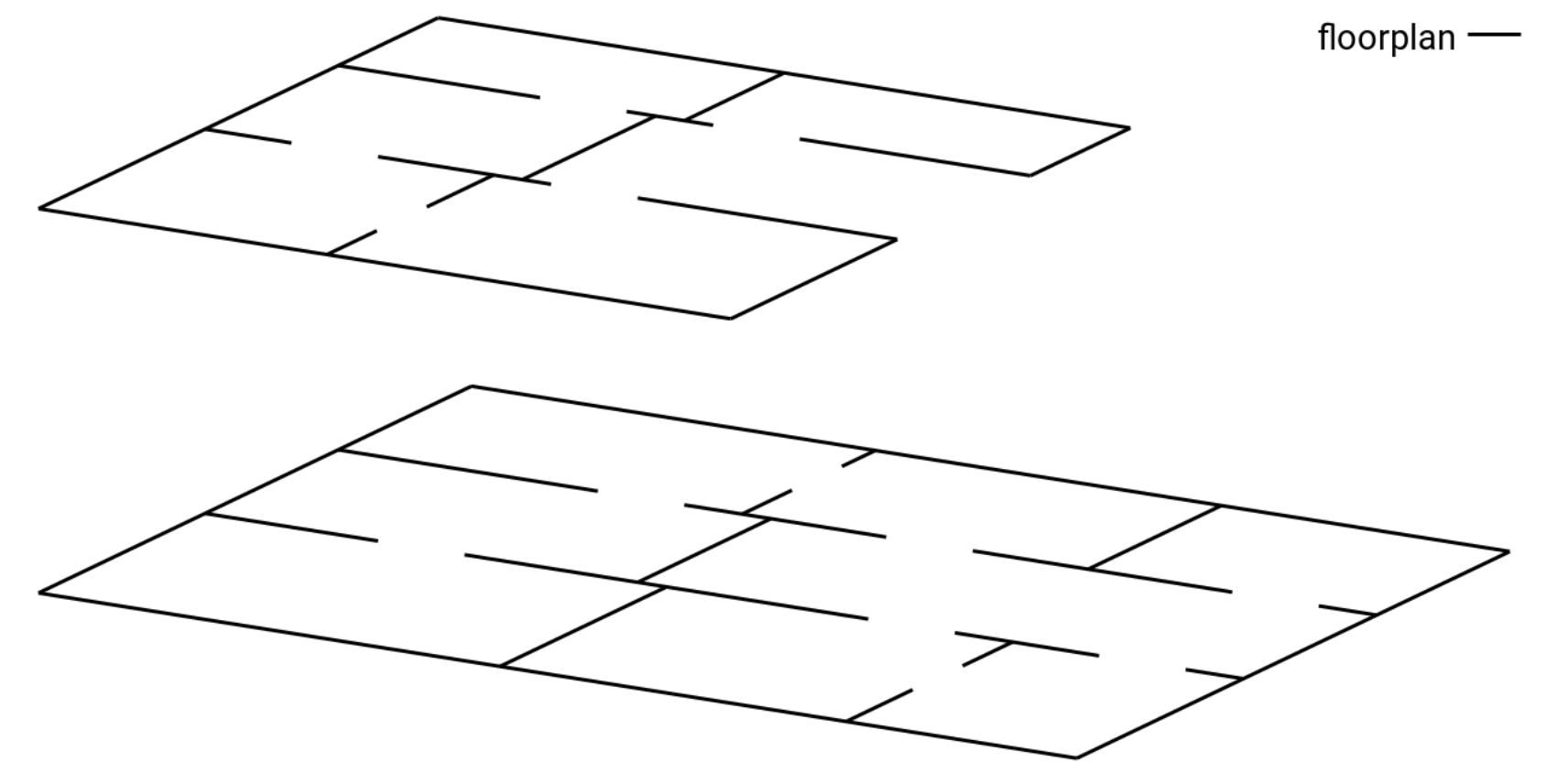
- a location's probability based on the current sensor readings

$$p(\boldsymbol{o}_t \mid \boldsymbol{q}_t) = p(\boldsymbol{o}_t \mid \boldsymbol{q}_t)_{\text{wifi}} \; p(\boldsymbol{o}_t \mid \boldsymbol{q}_t)_{\text{beacons}} \; p(\boldsymbol{o}_t \mid \boldsymbol{q}_t)_{\text{baro}}$$

- assuming statistical independence
- *step- and turn detection are used within the transition*

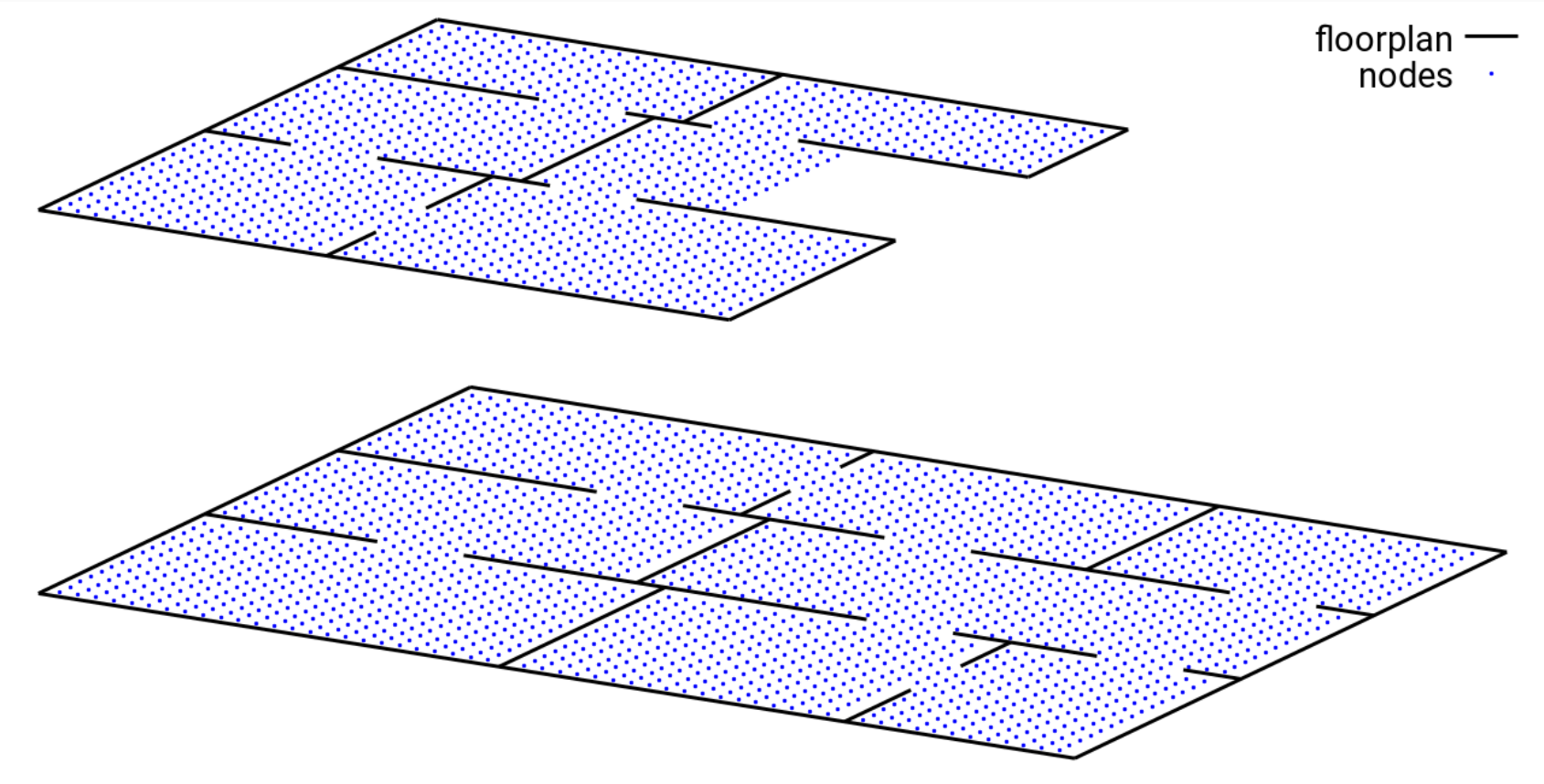
Transition - Floorplan

1) start with the building's floorplan



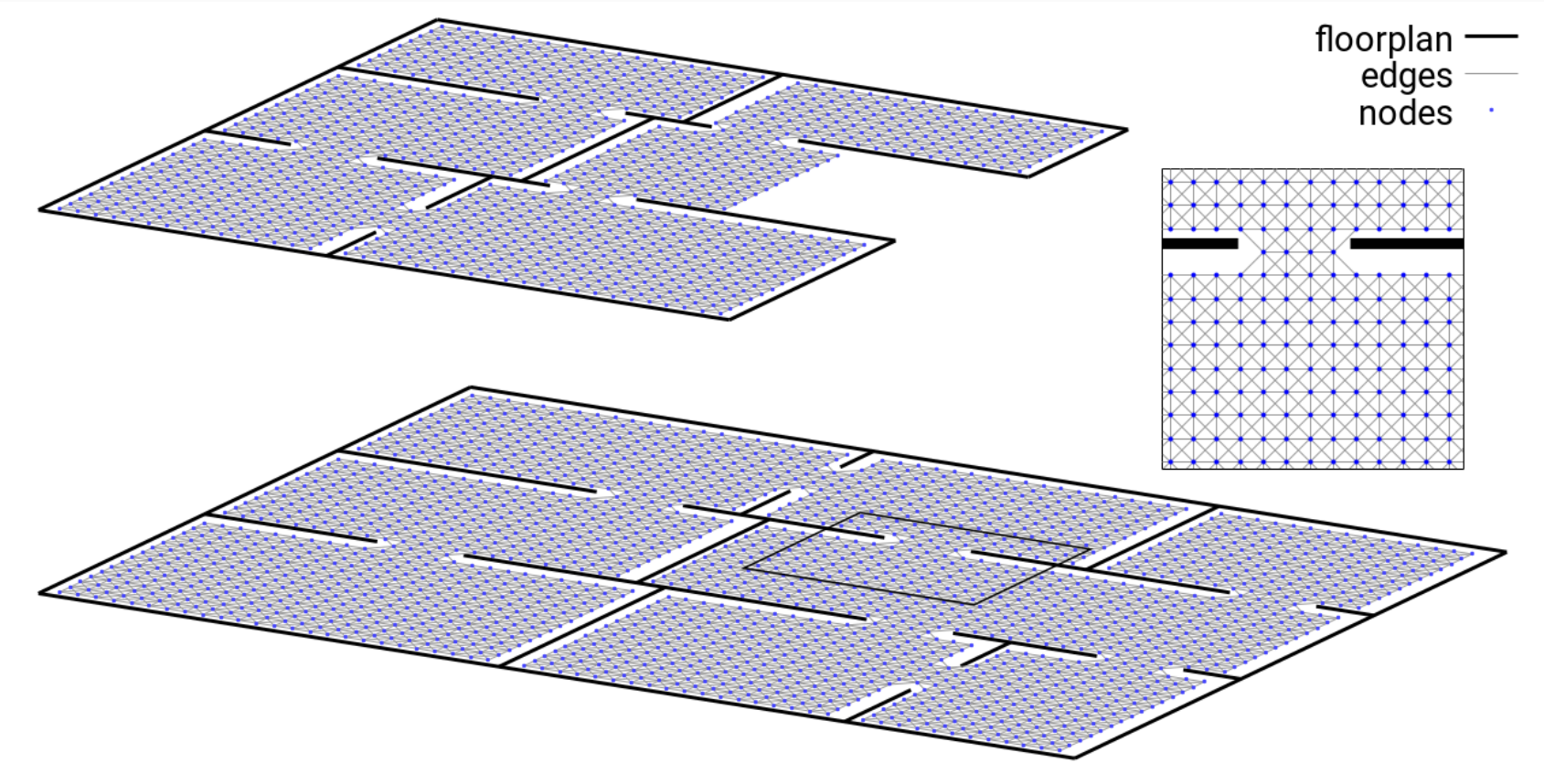
Transition - Floorplan

2) divide into cells and remove those intersecting with walls



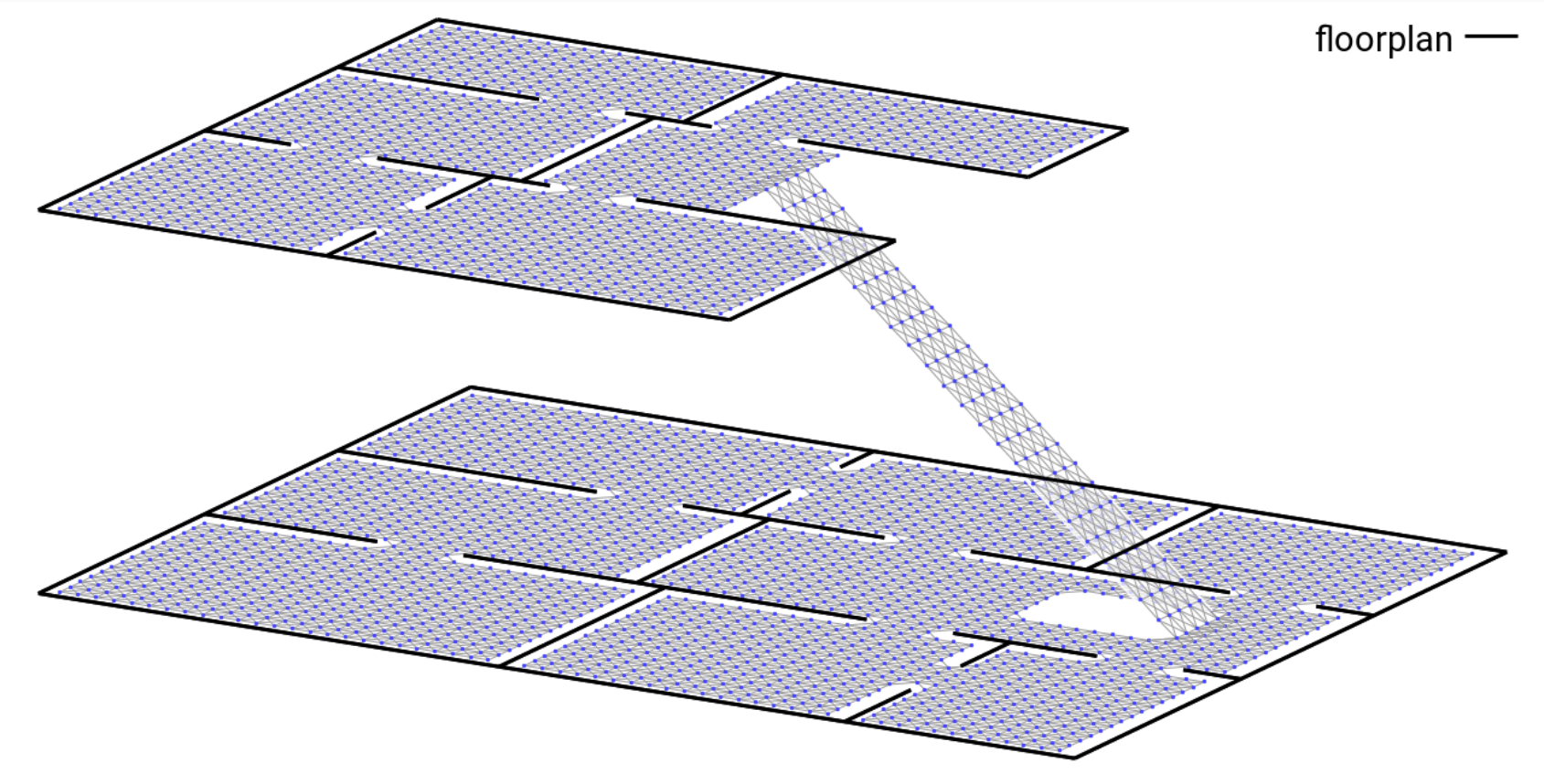
Transition - Floorplan

3) add edges to all (available) adjacent cells



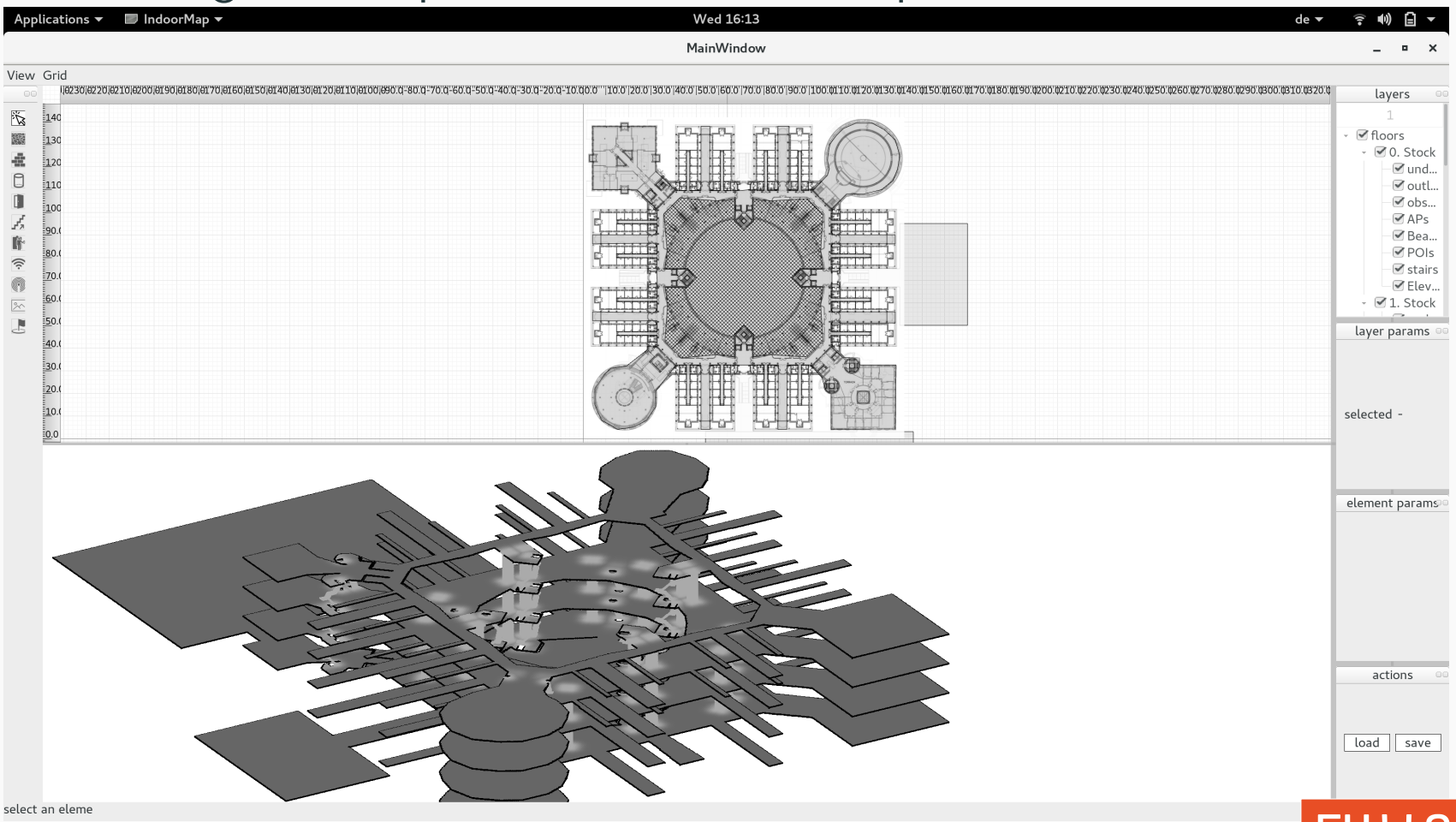
Transition - Floorplan

4) add stairs and remove unreachable cells



Transition - Floorplan

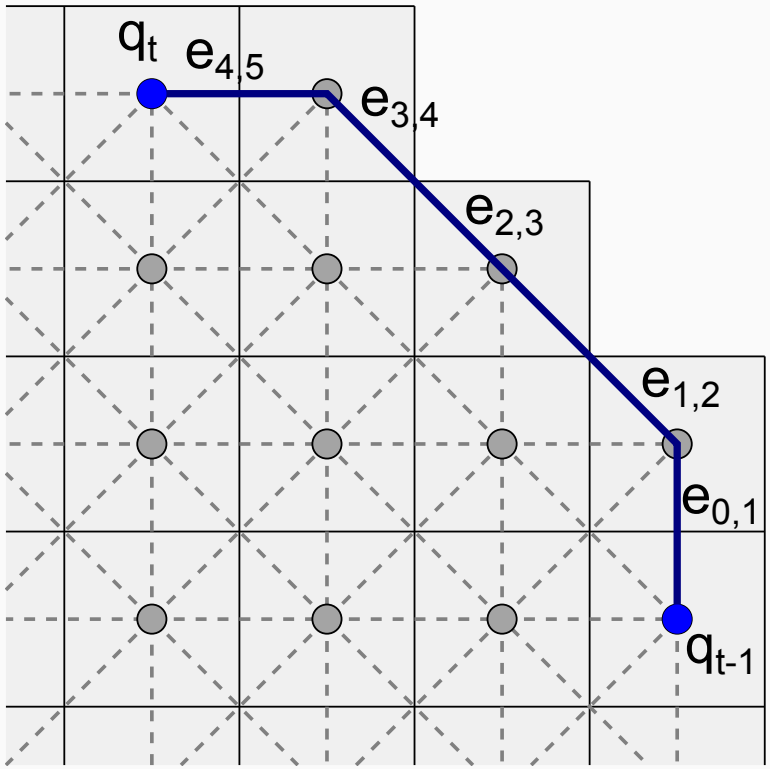
For drawing the floorplan we use our own map editor



Transition - Random Walk

$p(\boldsymbol{q}_t \mid \boldsymbol{q}_{t-1}, \boldsymbol{o}_{t-1})$:

1. get node $\boldsymbol{q}_{t-1}$ belongs to
2. draw distance d to walk
3. repeat until d is reached
   - 3.1 draw edge $e_{i,j}$ according to its probability $p(e_{i,j})$
   - 3.2 walk along the edge
   - 3.3 $d = d - \|e_{i,j}\|$



Backward Simulation

Algorithm 1 Backward Simulation Smoothing

Input: Prior $\mu(\boldsymbol{X}_1^i)$

for $t = 1$ **to** T **do** ▷ Filtering
  Perform particle filtering to obtain the weighted trajectories $\{W_t^i, \boldsymbol{X}_t^i\}_{i=1}^N$
end for
for $k = 1$ **to** N_{sample} **do**
  Choose $\tilde{\boldsymbol{q}}_T^k = \boldsymbol{X}_T^i$ with probability W_T^i ▷ Initialize realization
  for $t = T - 1$ **to** 1 **do** ▷ Smoothing
    for $j = 1$ **to** N **do**
      Compute the weights $W_{t|t+1}^j = W_t^j \; p(\tilde{\boldsymbol{q}}_{t+1} \mid \boldsymbol{X}_t^j)$
    end for
    Choose $\tilde{\boldsymbol{q}}_t^k = \boldsymbol{X}_t^j$ with probability $W_{t|t+1}^j$
  end for
  $\tilde{\boldsymbol{q}}_{1:T}^k = (\tilde{\boldsymbol{q}}_1^k, \tilde{\boldsymbol{q}}_2^k, \ldots, \tilde{\boldsymbol{q}}_T^k)$ is one approximate realization from $p(\boldsymbol{q}_{1:T} \mid \boldsymbol{o}_{1:T})$
end for

Backward Transition

Very simple model for calculating the state transition $p(q_{t+1} \mid q_t)$:

- Linear distance: $p(\boldsymbol{q}_{t+1} \mid \boldsymbol{q}_t)_{\text{step}} =$

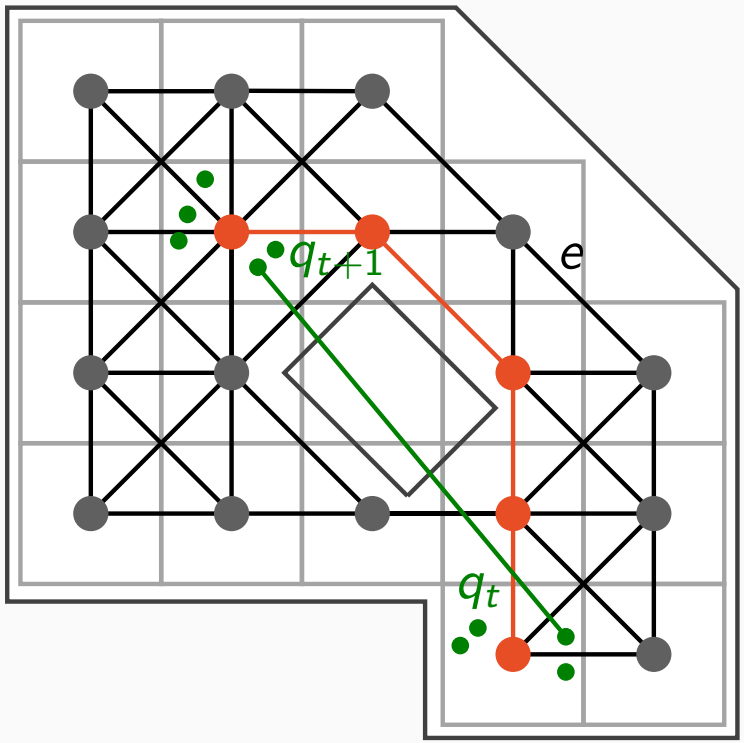
  $\mathcal{N}(\Delta d_t \mid \mu_{\text{step}}, \sigma^2_{\text{step}})$

- Heading change: $p(\boldsymbol{q}_{t+1} \mid \boldsymbol{q}_t, \boldsymbol{o}_t)_{\text{turn}} =$

  $\mathcal{N}(\Delta \alpha_t \mid \Delta\theta, \sigma^2_{\text{turn}})$

- Height change: $p(\boldsymbol{q}_{t+1} \mid \boldsymbol{q}_t, \boldsymbol{o}_t)_{\text{baro}} =$

  $\mathcal{N}(\Delta z \mid \mu_z, \sigma^2_z)$



Evaluation

Fixed-interval Smoothing - UAH (This building)

Filtered estimation (green) compared to smoothed estimation (blue).