

RM FOR USERS' SAFETY AND SECURITY IN THE BUILT ENVIRONMENT

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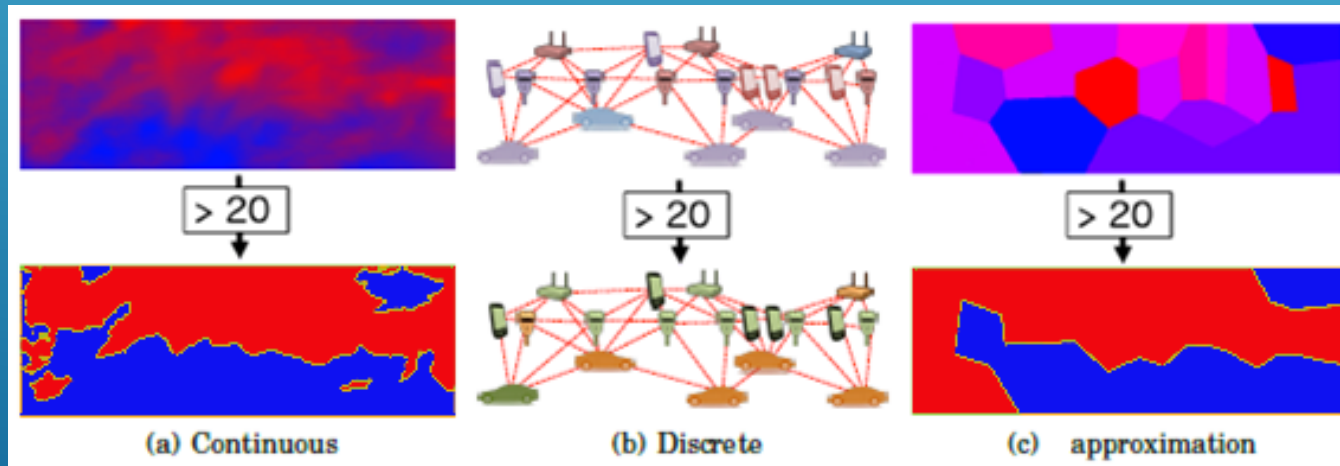
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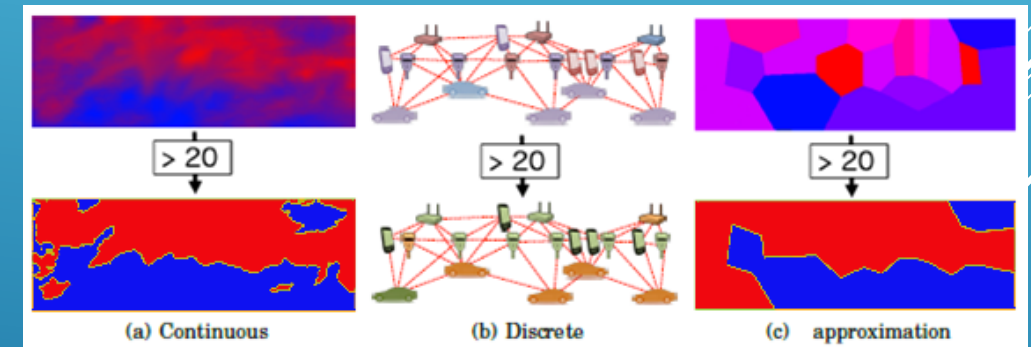
AGGREGATE MONITORING

- ▶ use Aggregate Programming system for distributed monitoring
 - Field Calculus minimal functional language for AP



AGGREGATE MONITORING

- ▶ use **Aggregate Programming** system for distributed monitoring
 - **Field Calculus** minimal functional language for AP
- ▶ define properties
 - **Past-CTL**
 - Spatial Logic of Closure Spaces (**SLCS**)
 - other?
- ▶ translate to Field Calculus monitors
 - done for SLCS
 - on-going for Past-CTL



SLCS SMART HOME EXAMPLE (I)

P true on points that are sensing the presence of people;

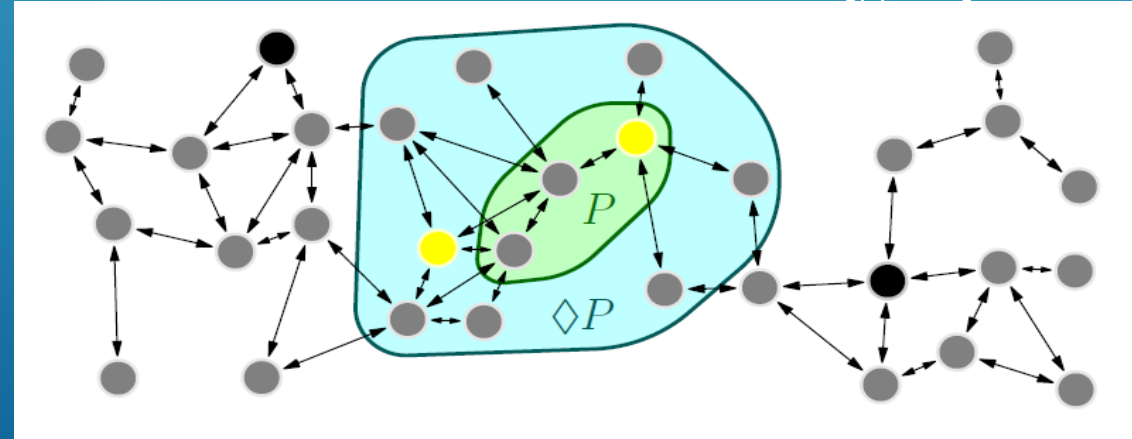
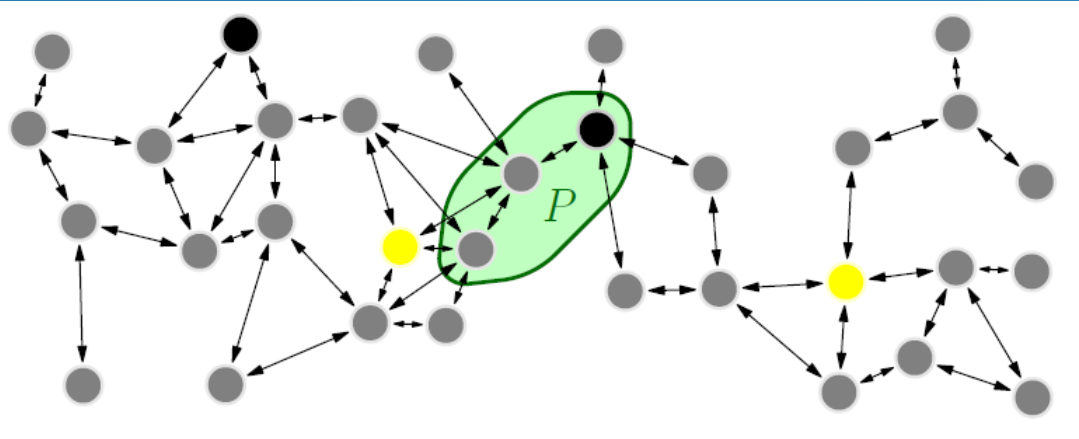
D true on points that correspond to monitored electrical device

O true on electrical devices that are on

$$\neg D \vee (O \leftrightarrow \Diamond P)$$

"true on points where (i) there's no monitored electrical device or, (ii) the device is on (O) iff there is some person **immediately near it**."

\Diamond local modality closure



SLCS SMART HOME EXAMPLE (II)

P true on points that are sensing the presence of people;

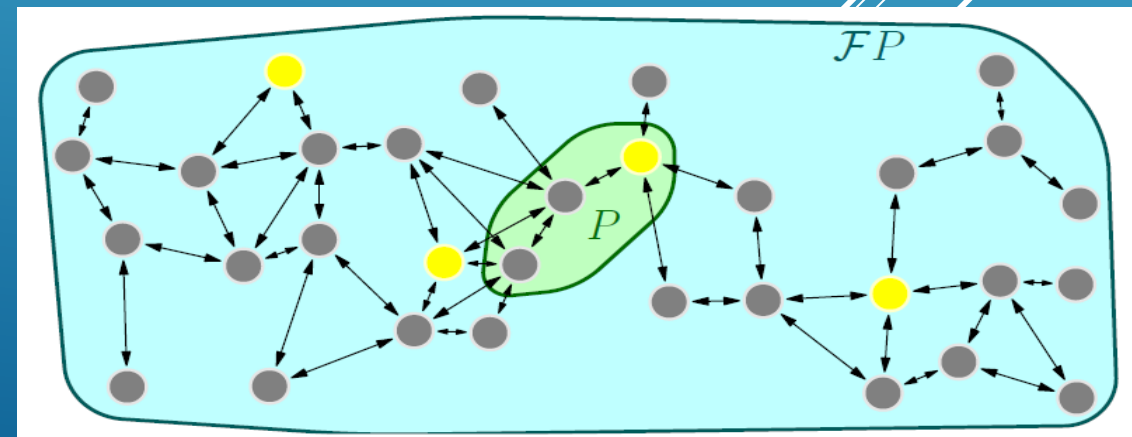
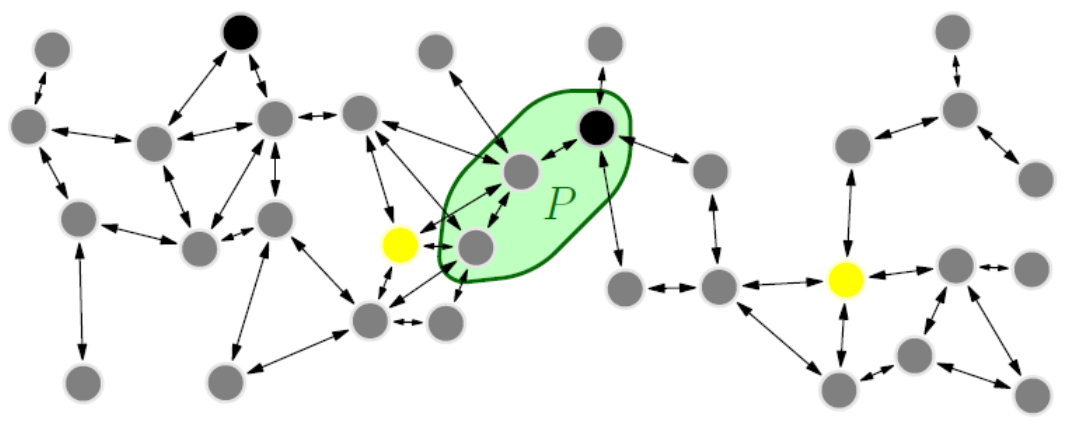
D true on points that correspond to monitored electrical device

O true on electrical devices that are on

$$\neg D \vee (O \leftrightarrow \mathcal{F}P)$$

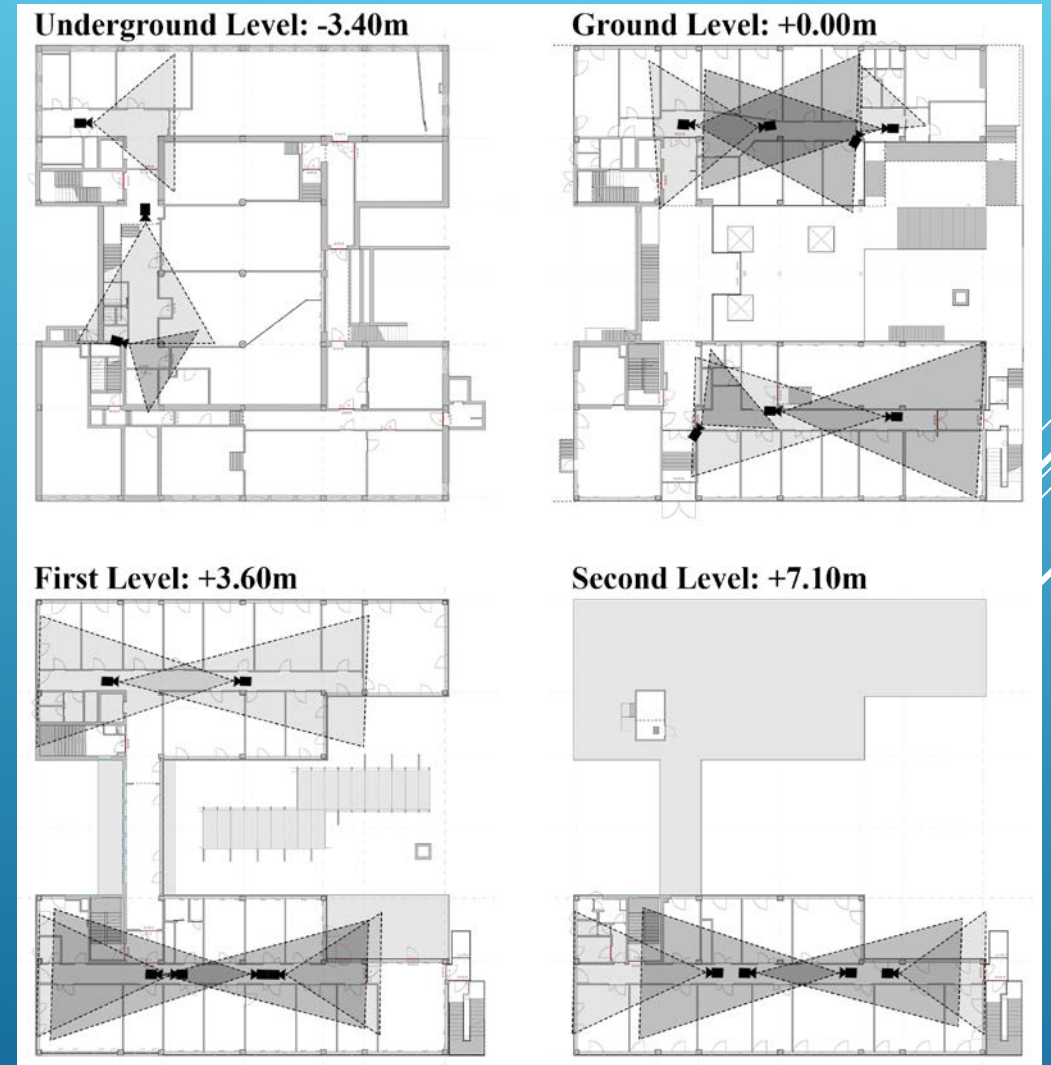
"true on points where (i) there's no monitored electrical device or, (ii) the device is on (O) iff there is **some person somewhere in the building**."

\mathcal{F} global modality **somehere**



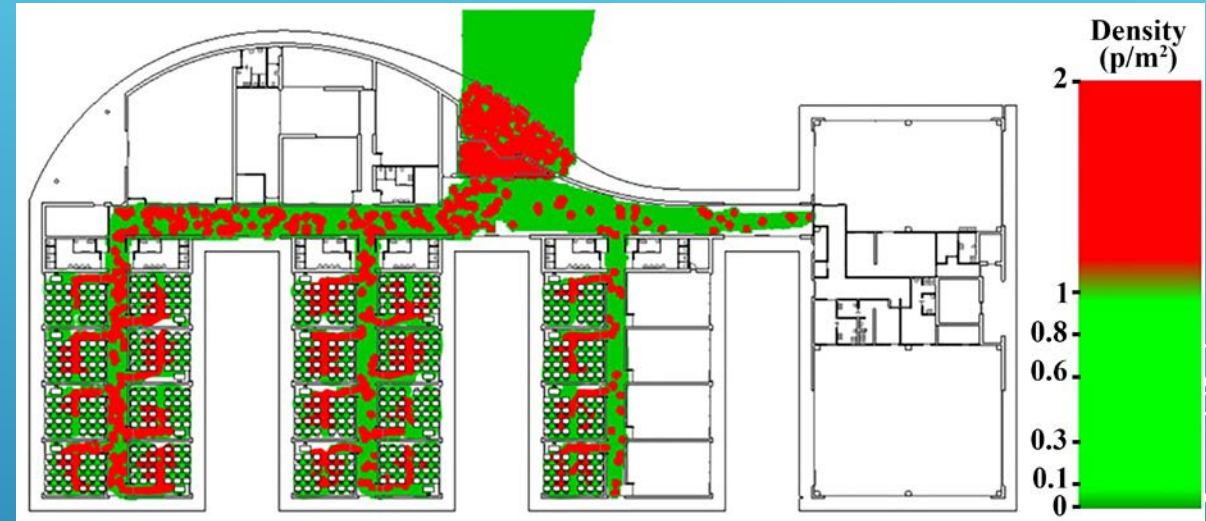
INDOOR USE CASES

- ▶ **offices building** (Milan, Italy)
- ▶ 4 story, 4300 m²
- ▶ existing fixed **network of cameras** for:
 - ▶ people counting
- ▶ need for:
 - **occupancy** analysis
 - emergency **egress paths**
 - social **distancing**



INDOOR USE CASES

- ▶ school building (Melzo, Italy)
- ▶ crowd simulations performed on BIM for:
 - occupancy analysis
 - emergency egress paths
- ▶ need for:
 - real-time management VS off-line analysis
 - social distancing



OUTDOOR USE CASE

- ▶ construction site (Inveruno, Italy)
- ▶ demolition and construction of school site
- ▶ BIM-based analysis of precast facades:
 - ▶ handling
 - ▶ installation
- ▶ manual health and safety
- ▶ need for:
 - proximity alerts to workers
 - dangerous areas marking
 - preventing access during loads movement

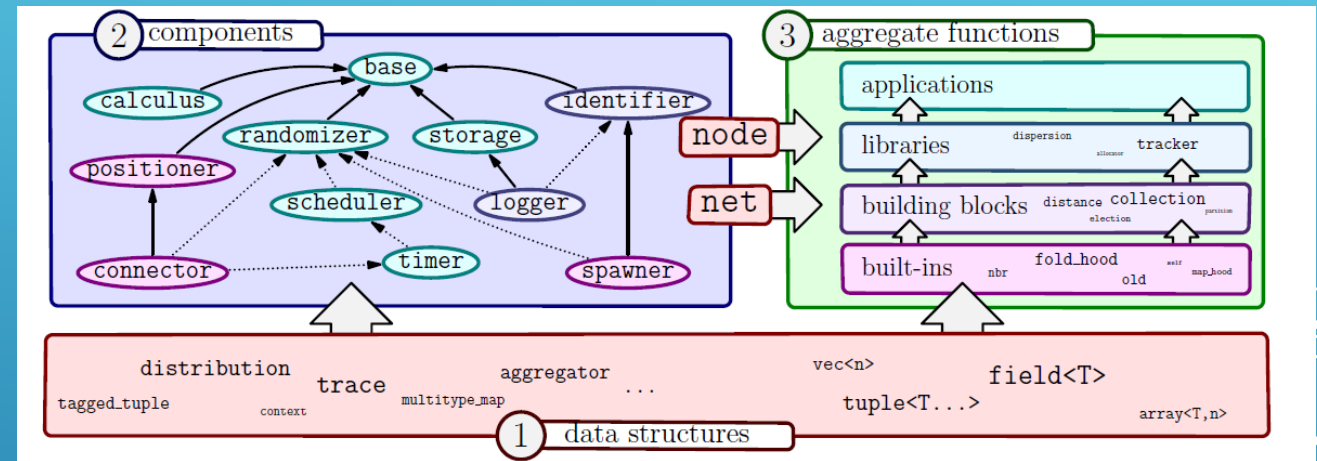


IDEAS FOR OCCUPANCY ANALYSIS (EXAMPLE)

- ▶ **count** the number of people in each room **Nr**
 - no need for monitor, just a Field Calculus program
 - **cross-check** with outcome of fixed net
 - rooms **not covered** by fixed net
 - **backup** of fixed net
- ▶ check that **Nr** is always **less than X**
 - simple temporal formula saying that it has never happened that a node has computed **Ov = Nr > X = true**
- ▶ check that there's at least **a path** to an exit **Ex** avoiding overcrowded areas **Ov**
 - simple spatial formula saying that there's a path along which **Ov=false** ending in a node **Ex=true**

AP ON PHYSICAL BOARDS

- ▶ **FCPP** C++14 library
- ▶ extensible library:
 - simulation
 - deployment on microcontrollers
 - other scenarios (e.g. HPC)
- ▶ new physical deployment:
 - access **physical sensors**
 - transceiver interface for the underlying platform
 - the **unique id** of the devices on the network
 - functions to **send and receive data** on the network
- ▶ industrial **partner Reply**



DECAWAVE 1001 DEVELOPMENT BOARD

- ▶ 62mm x 43mm
- ▶ two radio devices
 - Bluetooth Low Energy (BTLE)
 - Ultrawide Band (UWB) transceiver
- ▶ Nordic nRF52832 chip
 - ▶ ARM Cortex-M4 CPU
 - ▶ 512kB flash memory
 - ▶ 64kB RAM
- ▶ measures ranging accuracy to within 10cm
- ▶ can act as gateway to Ethernet



DECAWAVE 1001 DEVELOPMENT BOARD

Example: Real Time Locating System

