Location Awareness

Location Awareness can bring the following benefits

- Simplified commissioning
- More accurate reporting in telemonitoring situations => reliability
- Simulation and adjustment before commissioning
- Enhanced scenario support e.g. non-intrusive fall detection, energy management
- Integration to other concepts in the home automation area

Location awareness implies knowing the position of an entity in a given space. In a home this can be utilized twofold:

- Applied to static items like sensors, actuators, or household items => helping during installation, commissioning and maintenance.
- Applied to humans, by tracking their motion and behavior => makes the system more intelligent

There are several options for providing location awareness, like RFID, visual localization using cameras, audio localization based on voice, wearable tags, touch sensors, etc. The choice of the technology or combination of technologies depends on the specific application needs of the client.

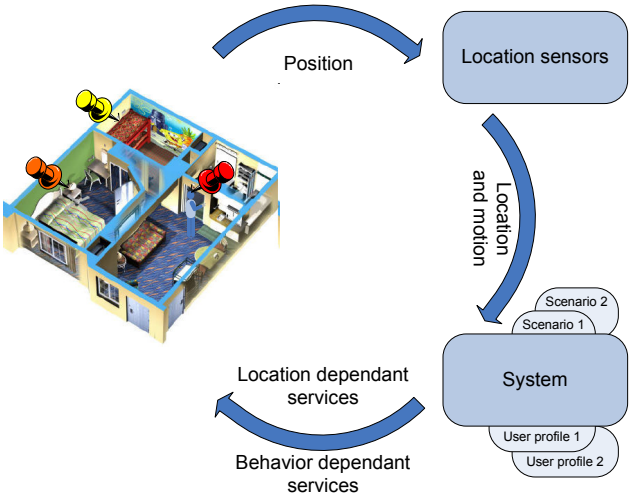

Figure 1: High level diagram of the location aware system

Item location awareness and visualization on floorplan

A modern home automation system consists of a significant number of control nodes, sensors and actuators spread throughout the home. During commissioning, all components have to be properly entered and configured using a configuration tool. The location and relative position of the components is important for identification and creation of logical device groups (e.g. which lights belong to kitchen etc). At the moment, all that information has to be entered manually.

Localization of system components greatly simplifies the commissioning. Using tags the devices can be located in the house with precision sufficient for accurate positioning on the **floorplan**. Also, the tag can provide information about the **device type,** capabilities, etc. The autodiscovery eliminates the need of manual entering devices and their position into the configuration tool - the discovered devices are automatically arranged on the floorplan.

In order to utilize location awareness of components, they have to be equipped with **RF tags**, while the area of interest should be covered by appropriate **RF reference points**. The reference points might be used only during commissioning and removed later, that way reducing the cost of the location aware technology to low-cost RF tags.

Positioning and rendering devices on a floorplan has several benefits:

- Commissioning
  - Simplified installation and configuration
  - Visual feedback about item position on the floorplan makes navigation and identification easier
  - The notification system can be improved by providing the exact location of the device to be serviced
  - Finding misplaced devices
  - Easy (visual) distinction between devices of same type in a room (e.g. 5 smoke sensors in a hallway, one is not working – it can be highlighted on the floorplan)
  - Automatic grouping into logical groups (e.g. all light in one room are automatically put into single logical group)
- Authoring (scenario creation & simulation prior to deployment)
  - Eases scenario creation by deriving further information from the device positions (e.g. when the DVD is started, turn on the nearest TV – most likely that one is connected to the DVD)
  - Allows more intuitive visual programming of actions and scenarios – visual referencing to devices
  - Allows visual simulation and verification of the scenario effect, thus offline scenario development

To achieve the above, the existing configuration tool has to be extended with:

- Autodiscovery module supporting location awareness
- Additional view supporting floor plan and visual rendering of devices and scenarios, which can coexist with the existing tree-like hierarchy. The new view could be equally used as the existing tree-like hierarchy view.
- The floorplan can be either a CAD drawing, 2D sketch of the floor, or it could be generated by a generic floor plan editor that might complement the existing tool.

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People location awareness

Energy saving:
Locating people in the house (or building) can be utilized for recognizing behavioral patterns that supports optimization of energy consumption. The optimization can be applied to light, HVAC as well as other appliances.
Some possible scenarios are:

- Turn off the light or TV if there is nobody in the room for a while. When the person returns, turn them on again.
- Adapt the heating according to the daily activities of the family – heating is on when there is a lot of activities (morning and afternoon), lower until lunchtime and during night. The system can deduce that pattern without requiring any inputs from the user.

These scenarios can be either preprogrammed or recognized by the system. Based on the sensor readings they can adapt over time. The system can utilize existing low-cost sensors like motion sensors, occupancy sensors, etc. The ability of the system to track the user habits and learn from them eliminates the need of re-programming and installer assistance in system tuning.

Telemonitoring - Fall-detection:
Precise location awareness of people in the house ensures more accurate reporting in telemonitoring situations. It can be used for detection and alarming in situations when the person cannot ask for help.
The fall-detection feature aims to identify potentially dangerous situations when a person falls, and cannot stand up. Following a fall the person might be either conscious or unconscious.
In case of consciousness, alarm buttons put at appropriate places might be a solution. In case of unconsciousness, the system has to be intelligent enough to distinguish between regular situations without movements (e.g. sleeping) and real falls. The system has to be reliable in order to avoid false alarms (e.g. sitting on chair) and avoid unnecessary stress and concern towards the primary carer.

One way of performing fall-detection in a passive way is to do it visually; using commercially available **optical cameras coupled with detection algorithms and combining this with a range of other sensors deployed in the home** (e.g. motion detectors, occupancy sensors, contact sensors etc). The area of interest in and around the house should be covered by the relevant sensors. The intelligent camera would track the person silhouette while it is moving, and it would detect change in silhouette typical for a fall. Tracking the head trajectory in time can provide additional information about the fall. The detection of a silhouette on the floor is also a sign of fall. By combining a camera with other (simpler) sensors, the system reliability is increased. The intelligence may also be distributed between the camera and master controller, taking into account the cost and complexity perspective of the system.

Usage of cameras might be inconvenient in situations when **privacy** is critical, like in bathrooms. In such cases other, **less intrusive sensors** can be used, like:

- motion detectors (people usually move during taking a shower)
- shower cabinet door sensors (door opened/closed)
- shower flow sensors (water is on or off)

An alarming scenario would combine the readings of those sensors respecting the timeline of their events and compare to typical behavior of people. In case someone would spend more time than normal in the shower and also the door contact was not released, the alarm could be raised. Same if no motion is detected during a certain period of time in the shower. Both cases could be an indication that the person has fallen and cannot get up, therefore they need help.

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Notification elements:

The fall detection feature has to be well supported by the **configuration and commissioning tool**. The tool has to support the easy installation of camera and definition of regions of interest in the room and house, as well as other sensors.

Also, the system should support notifications based on various number and type of sensors. This can be achieved by improving the notification subsystem, e.g. by:

- Introduction of wizards for notification definition – easy to understand approach for non-skilled people
- Introduction of notifications that are dependent on multiple sensor events in a user friendly manner
- Extension of the existing system with scripting engine that would make possible definition of more complex notifications and scenarios – suitable for skilled persons