Home Automation

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Application scenario in real life

- Temperature sensing
- Movement sensing
- Energy management
- Smart household appliances

Real example: Samsung Smart Fridge

Food management

- Create shopping list
- See inside the refrigerator with 3 built-in cameras
- Set food exipiration notifications
- Suggested receipes based on user's food preferences

Family connection

- Smart calendar able to send notes to the familiy
- Possibility to create To-do lists for each family member

Entertainment capabilities

- Stream music and video
- Display useful information on fridge's screen

Sensors: classification

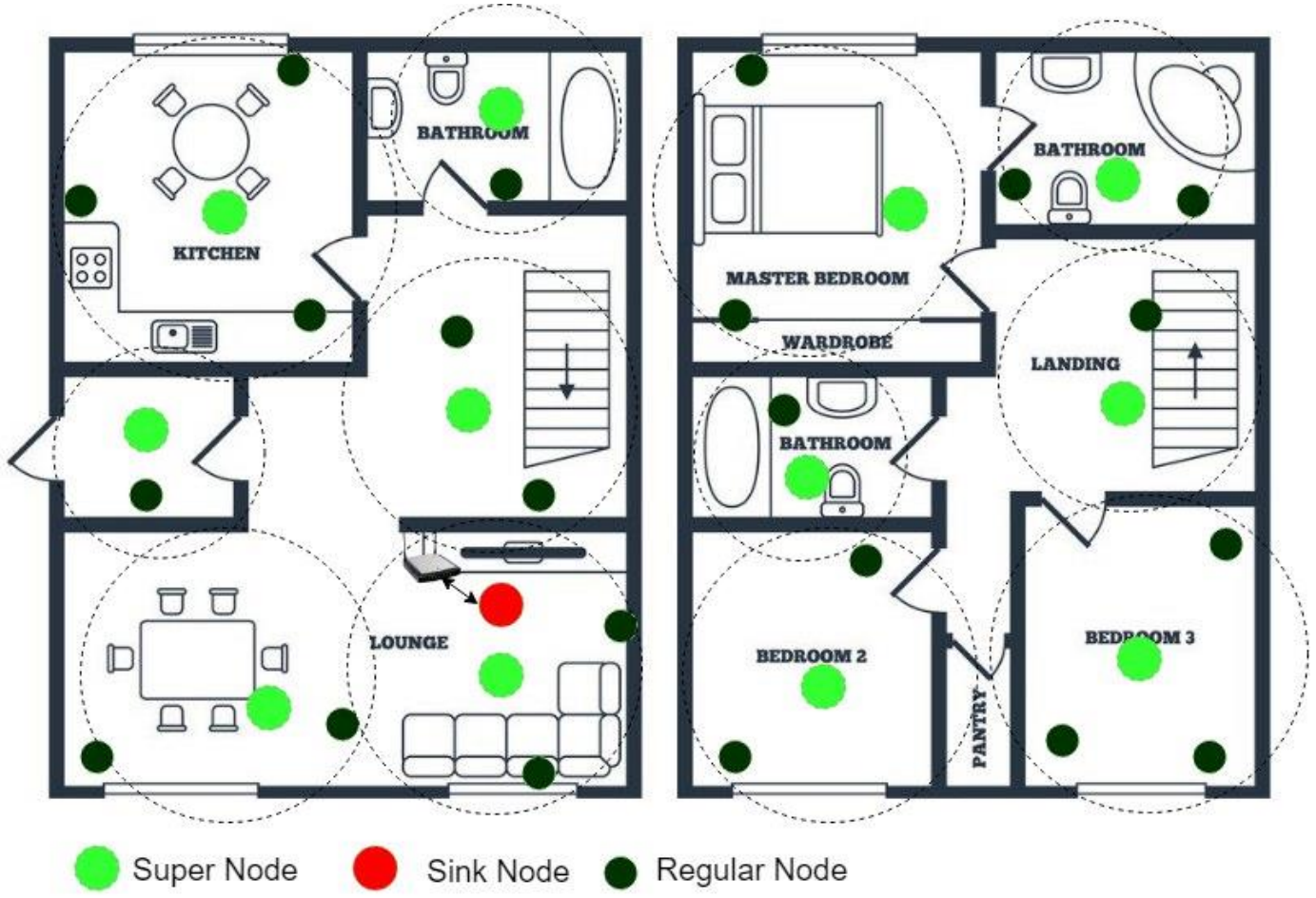
Non - Constrained sensors

- Base station
- Smart meters
- Smart oven
- Smart fridge
- Smart window
- Smart locks

Constrained sensors

- Temperature
- Humidity
- Movement
- Light intensity
- Chemical
- Robot Vacuum Cleaner

System architecture



- Static and Sparse Wireless Sensor Network
- Single-Hop Hierarchical Routing with **Super Nodes** and **Regular Nodes**

MAC protocol: IEEE 802.15.4

- **Low duty-cycle MAC protocol**
- **Non-Beacon Enabled** channel access mode
  - Perfect for monitoring applications (radio can be switched off if no transmissions are required)
  - Does not require synchronization between nodes

- **PAN coordinator** collects data from sensors and forward them to the base station
- Each room has its own PAN coordinator

Routing protocol: ZigBee

- **Cluster-tree** topology
- **Parent-child** routing
- Can exploits both Beacon-Enabled and **Non-Beacon Enabled** modes of IEEE 802.15.4 MAC

Human benefits

Set preferences without forcing the user to intervene directly on the device, but acting comfortably via smartphone or other devices used in everyday life.

Pre-setting of the appliances in order to plan automatically the beginning of their working phase to ensure the best energy efficiency taking into account pricing structure of the utility companies.

Protect the health of people in the home by monitoring, for example, the level of gas and smoke inside the home in order to switch on actuators to avoid possible dangers.

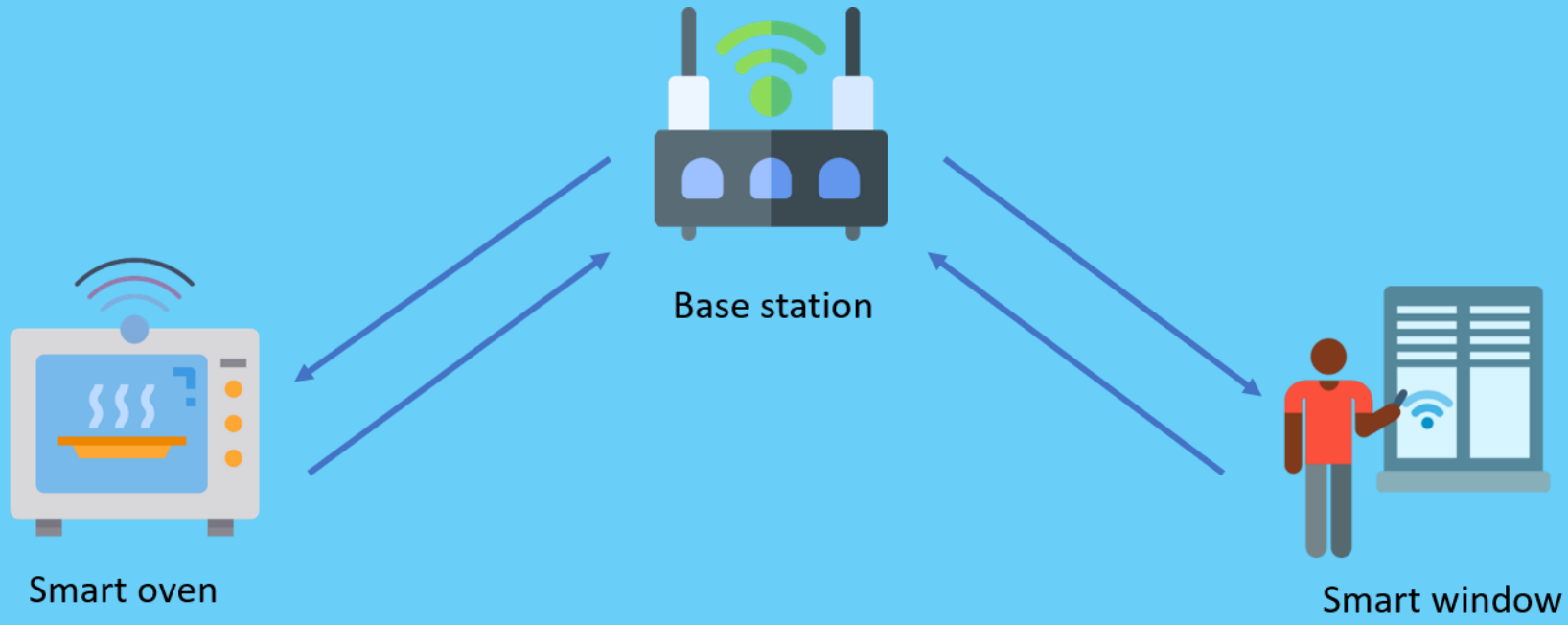
Environmental benefits

Using motion and presence sensors, you can automatically turn off the lights in the rooms, so as to prevent waste.

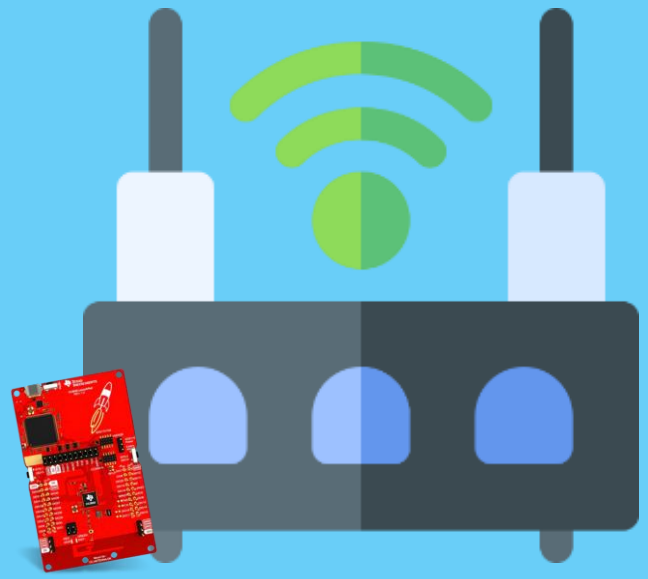
Automatically switch off the heating or cooling system of the house when the ideal temperature has been reached.

Avoid operating the air conditioning if the outside air is cooler and less humid, but open the window in this case.

Prototype Architecture



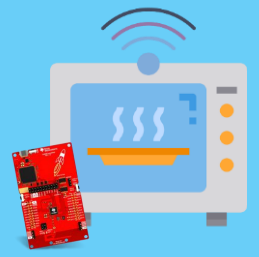
Discovery phase



- Base station sends broadcast messages to discover MAC address of sensor nodes
- Handle nodes disconnection
- Two types of timer:
  - Broadcast retransmission
  - Broadcast phase reactivation
- LEDs show the discovery phase status

Devices features

- Base station mantains the status of each node
- Menù to perform actions on available devices
- Custom command set for each device:



- **Oven:**
  - Choose cooking temperature and time

- **Window:**
  - Opening/closing in automatic or manual mode
  - Choose timer for lifting/lowering roller shutter
  - Choose preferred temperature/humidity value