



# Mapping of Smart Home Technology and Current Trends

## Webinar for Stakeholder Consultation

19<sup>th</sup> June 2020



Implemented by

**giz** Deutsche Gesellschaft  
für Internationale  
Zusammenarbeit (GIZ) GmbH



# Agenda



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## Content

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Smart home concept

Drivers enabling smart home

Technology trends in smart home space

Smart home technology mapping

Performance of smart home system

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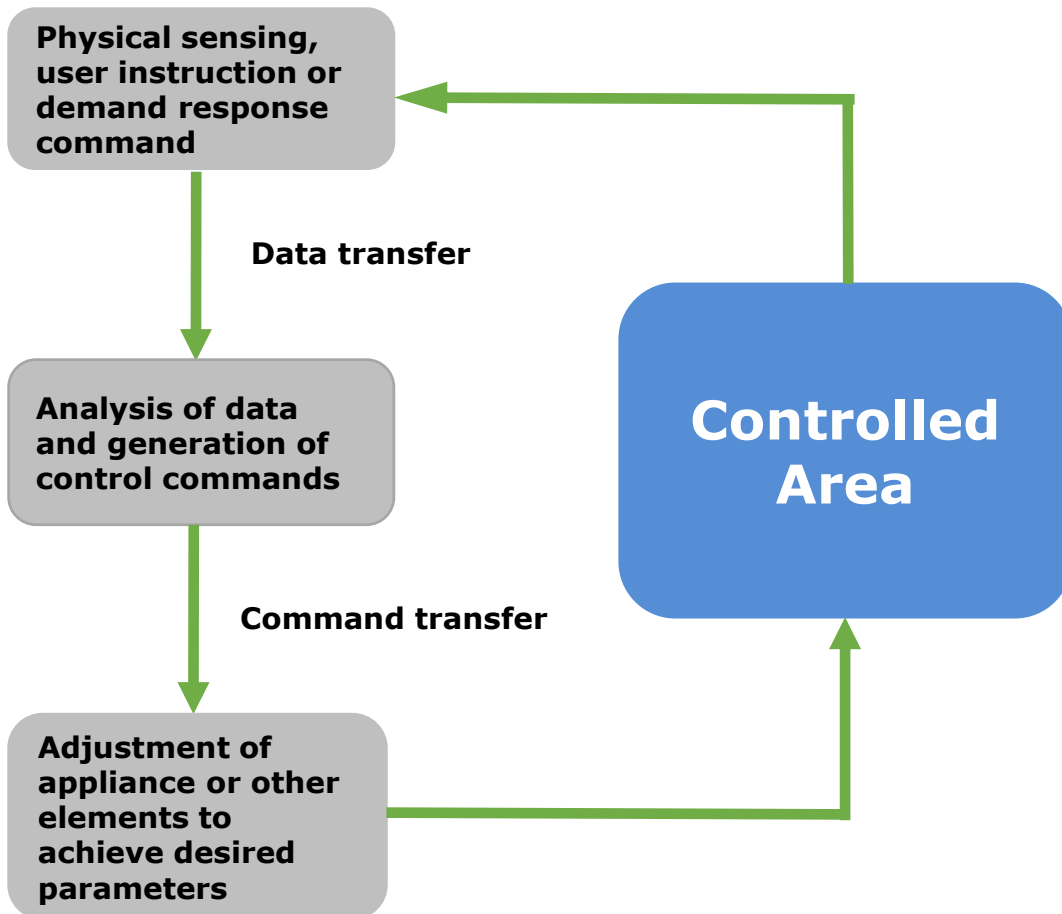




# Smart home Concept



## Concept

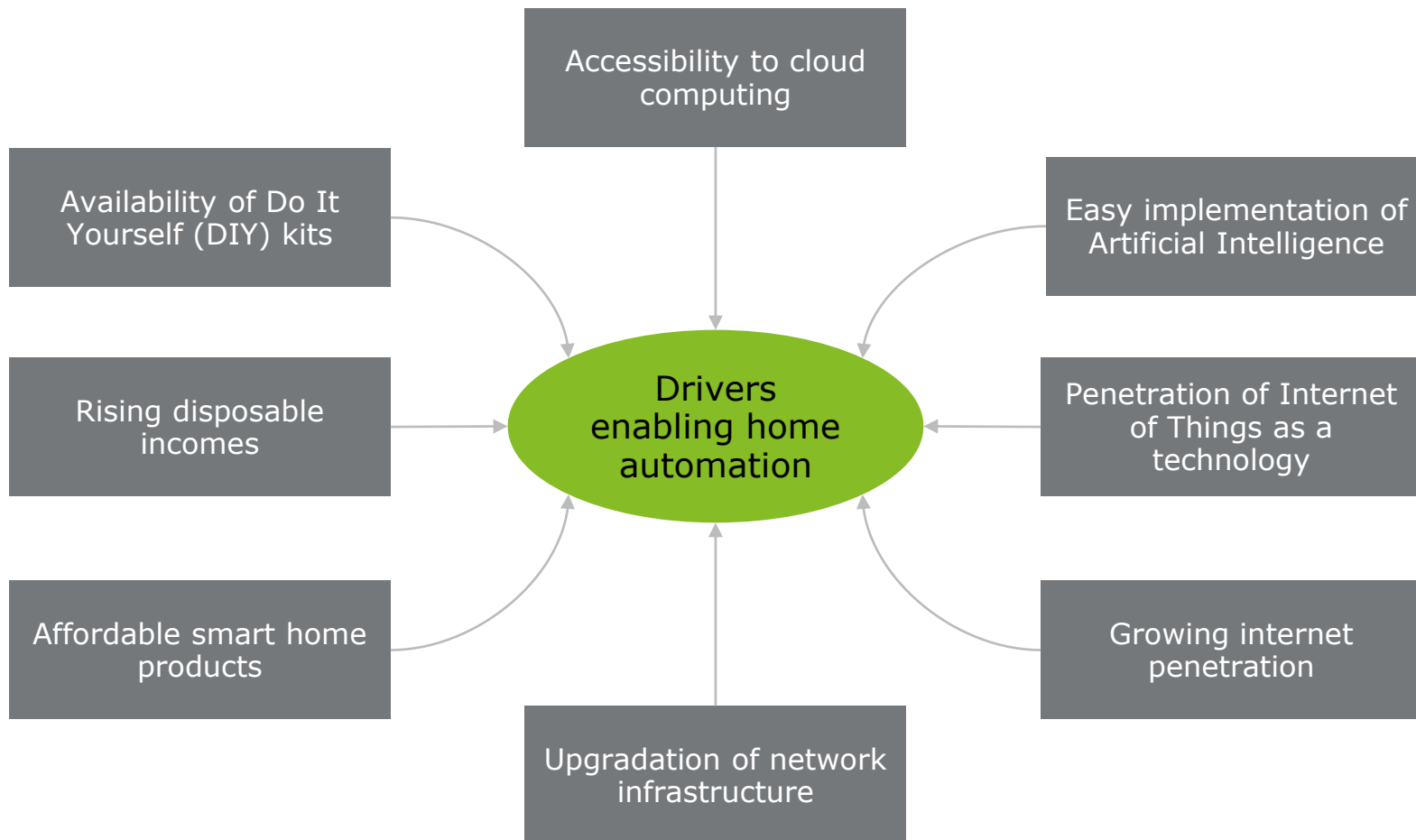


## Energy and cost savings is achieved by

- ❑ Preventing **idle running** of energy consuming device
- ❑ **Optimization** of adjustable building envelope elements
- ❑ Optimization of **operating parameters** to match user preference
- ❑ **Shifting** the operation of non-essential energy consuming device to off peak time
- ❑ Making use of **renewable energy** generation source, whenever available to meet the energy demand
- ❑ **Storage** the surplus renewable energy to offset peak demand



# Drivers enabling smart home





# Current technology trends



## Current technology trends

- Entry point devices - Voice controlled speakers, routers Set-top boxes
- Smart homes as a service
- Standard fitment
- Value added services
- Smart devices
- Smart home aggregators
- Standardization and interoperability
- Connected Home over IP project
- Artificial Intelligence
- Chatbots
- Energy harvesting



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- Smart gadgets have entered homes through devices such as routers, set-top boxes and voice-controlled speakers
- Connectivity, communication and entertainment are the drivers
- Wi-Fi routers (Samsung SmartThings V3) and Set-top boxes (Cox Communications and Comcast) are becoming Smart home hubs



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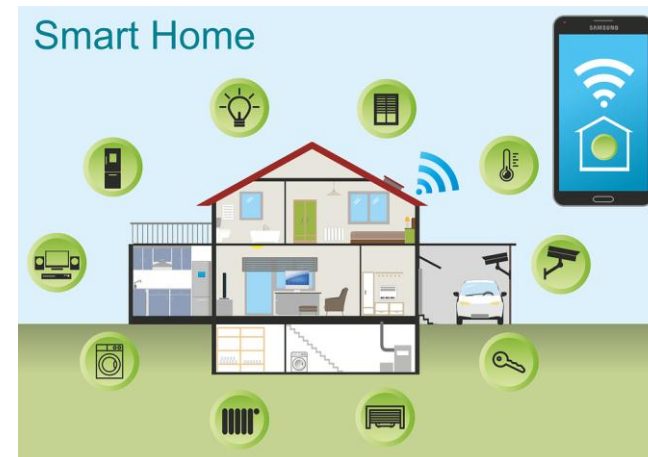


- Driven by utilities, telecoms and cable network providers
- Devices are just the components it is the service that matters
- Single app that can manage the entire suite of home services with a common user interface
- Evolving hardware ownership models which avoid technology obsolescence



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- Home automation is being conceived as a standard fitment in new homes.
- Builders are showing interest and offering Smart Homes





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- Value added services including Fault Detection and Diagnostics, maintenance and warranty facility will be an integral part of these standard home automation fitments
- Energy management at the appliance level, and the prediction, detection, and diagnostics of faults for grid assets and home appliances, will improve operational planning, reduce peak demand, increase energy savings, etc



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- Smart devices such as speakers, lights, water heaters, AC, washing machine, are either connected to the internet or can take commands locally
- It is possible to interconnect devices and use single App for control and monitoring

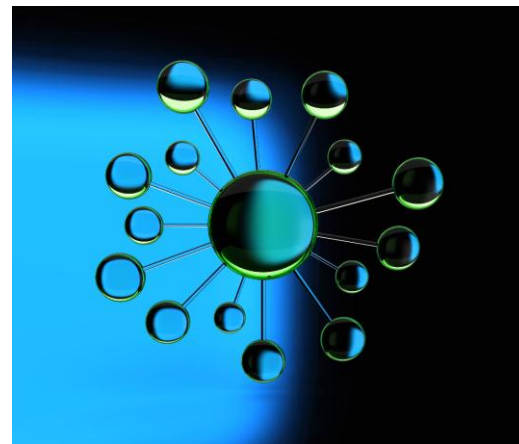


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- Aggregators in the building sector, such as dedicated organizations, builders and technology promoters, enable the needed bridge between utilities and consumers to simplify the implementation of demand response
- Organizations like EFI have been helping people and organizations purchase quality conservation products at affordable prices

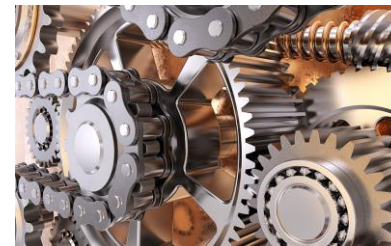


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- Standardization and interoperability are vital for ensuring the success and security of IoT solutions in the home automation sector
- The Open Connectivity Foundation (OCF) members and ATIS have collaborated to develop an open source implementation of an interworking proxy as a pivotal step to facilitate seamless user access to a wide range of IoT services
- OCF and oneM2M have developed harmonized standards to permit seamless interworking between oneM2M and OCF environments



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- Project Connected Home over IP is a new Working Group within the Zigbee Alliance. This Working Group plans to develop and promote the adoption of a new, royalty-free connectivity standard to increase compatibility among smart home products, with security as a fundamental design tenet
- Amazon, Apple, Google, and the Zigbee Alliance joined together to promote the formation of the Working Group

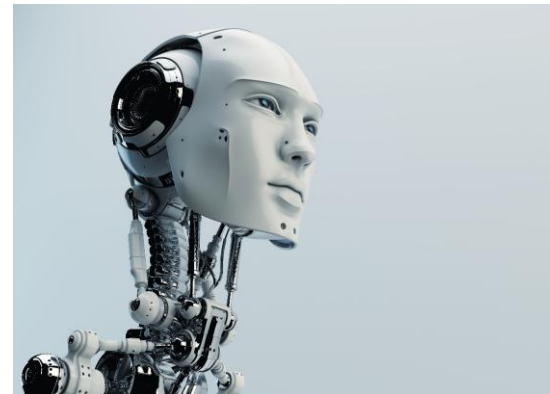


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- Artificial Intelligence is catching up to automate most actions leaving out the need for integration
- B.One is a self-learning Home Automation and Security Hub. It runs on the proprietary Artificial Intelligence Engine InstinctAct® which analyzes and predicts actions



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- ChatBots are emerging as a mode of customized interface, simplifying interfacing and making it more universal.
- B.One™ Hub is one of the first Home Automation Hubs to understand and leverage the potential of integrating Chatbots for a highly effective and a wide reaching IoT interface solution.



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## Wi-charge



- Best innovator CES 2018 - A wireless product that enable full room wireless-power coverage.
- Wi-Charge's technology utilizes infrared beams to transfer power between a charging hotspot and client devices within a 10-meter range.
- Wi-Charge is the first company to achieve the power/range/safety level required for a commercial wireless power solution.





## Hardware

### 1. Hubs

- Voice controlled hubs
- App controlled hubs

### 2. Smart appliances

- Smart blinds
- Smart thermostats
- Smart IAQ devices
- Smart AC
- Smart washing machine
- Smart refrigerator
- Smart geysers
- Smart lighting
- Energy monitoring systems

### 3. Computing

- Cloud computing
- Edge computing

### 4. Communication

- Wired communication
- Wireless communication – Short range
- Wireless communication – long range

### 5. User Interface

- App/dashboard-based interface
- Voice based interface
- Gesture based interface



## Software

1. Proprietary
2. Open source



# Technology Mapping - Hubs



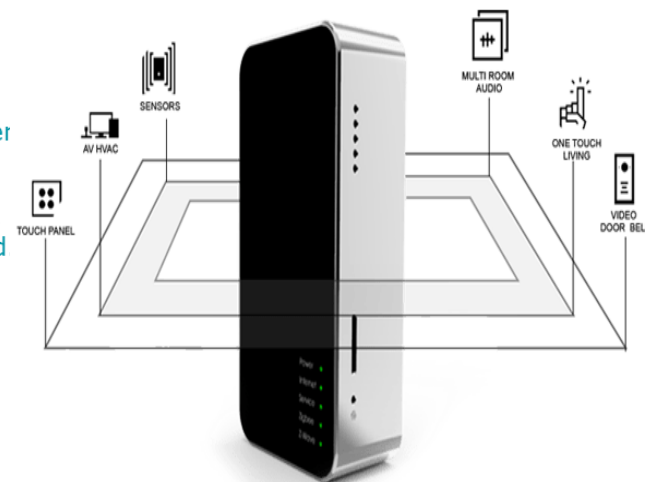
A smart home hub is hardware that connects devices on a home automation network and controls communications among them. It acts as the heart of a smart home network, connecting different devices and systems in a centralized platform.



01 >

## Voice based hubs

These hubs have a speaker and user can interact with it over voice commands. Voice based hubs rely on cloud computing and it connects with smart home devices over cloud



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## App based hubs

It has a software application which can be operated on any computing device such as mobile, tablet, laptop, PC etc. and it connects smart home devices over either of Wi-Fi, ZigBee, Bluetooth or IR.



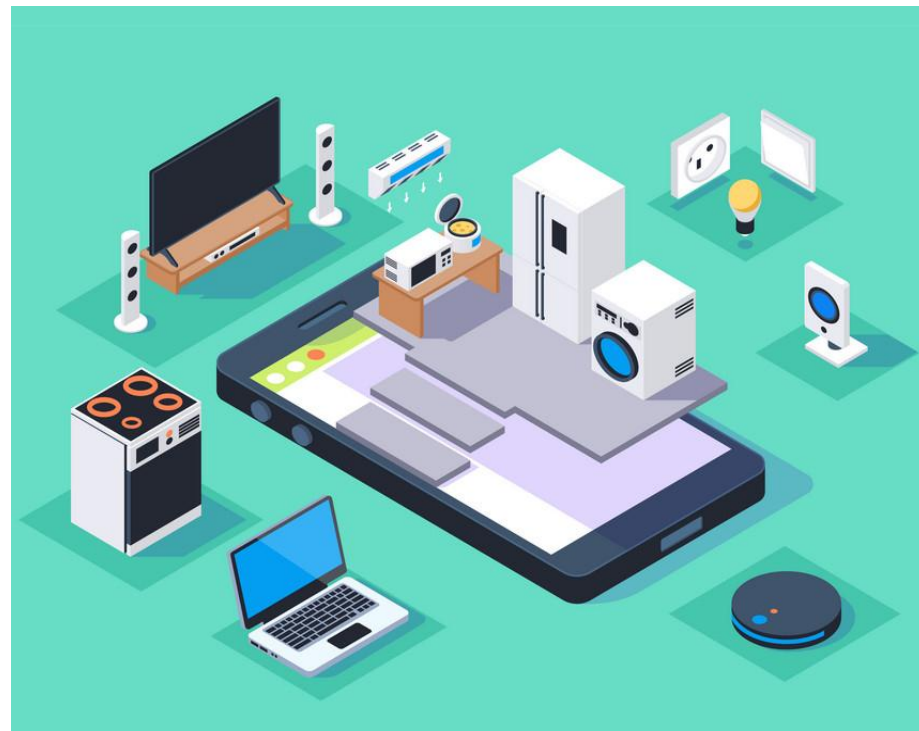


# Technology Mapping – Smart appliance



Smart appliances are the devices that can be connected with hub or directly to Internet using home Wi-Fi. These devices can push information and also receive commands from other devices or the users. Some of these devices can be controlled by utility or the aggregators.

Smart blinds	Smart Thermostats	Smart IAQ Devices
Smart AC	Smart Washing Machine	Smart Refrigerator
Smart Geysers	Smart Lighting	Energy Monitoring Systems

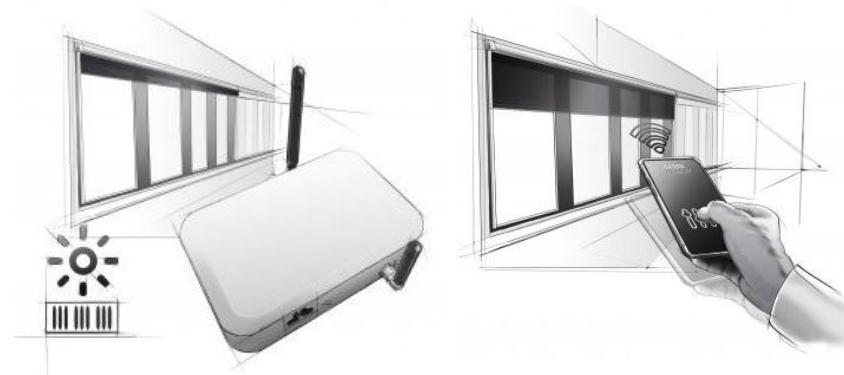




# Technology Mapping – Smart appliance



<b>Smart blinds</b>	Smart Thermostats	Smart IAQ Devices
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Particular	Details
User interface	<ul style="list-style-type: none"> <li>• Touch: Manufacturer app</li> <li>• Voice: Alexa or google assistant</li> </ul>
Connectivity	Bluetooth, Wi-Fi
Display	Smart phone or tablet
Features	<ul style="list-style-type: none"> <li>• Voice or app or remote based control</li> <li>• Battery powered, optional solar PV system for charging</li> <li>• Sun tracking and manual scheduling options are available</li> <li>• Can be linked with smart AC, smart hub, smart IAQ devices</li> </ul>



# Technology Mapping – Smart appliance



Smart blinds	<b>Smart Thermostats</b>	Smart IAQ Devices
Smart AC	Smart Washing Machine	Smart Refrigerator
Smart Geysers	Smart Lighting	Energy Monitoring Systems



Particular	Details
User interface	<ul style="list-style-type: none"> <li>• Touch: Manufacturer app</li> <li>• Voice: Alexa or google assistant or Apple Home or Nest</li> </ul>
Connect over	<ul style="list-style-type: none"> <li>• Wi-Fi</li> </ul>
Display	<ul style="list-style-type: none"> <li>• In build or Smart phone or tablet</li> </ul>
Features	<ul style="list-style-type: none"> <li>• Voice or app-based control</li> <li>• User can monitor, control and schedule (set temperature) thermostat from anywhere</li> <li>• Smart thermostat learns from user preference and keep track of weather conditions to minimize the energy consumption of HVAC system</li> </ul>



# Technology Mapping – Smart appliance



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User interface	<ul style="list-style-type: none"> <li>• Touch: Manufacturer app</li> <li>• Voice: Alexa or google assistant</li> </ul>
Connect over	Bluetooth, Wi-Fi
Display	Smart phone or tablet
Features	<ul style="list-style-type: none"> <li>• Voice or app-based control</li> <li>• Monitors the Air Quality, temperature and humidity at anytime and can be accessed from anywhere</li> <li>• Controls appliances such as air purifier, AC, fan, dehumidifier to Control or maintain air quality parameters at user preference or set point</li> </ul>



# Technology Mapping – Smart appliance



Smart blinds	Smart Thermostats	Smart IAQ Devices
<b>Smart AC</b>	Smart Washing Machine	Smart Refrigerator
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Particular	Details
User interface	<ul style="list-style-type: none"> <li>• Touch: Manufacturer app</li> <li>• Voice: Alexa or google assistant</li> <li>• IR remote control</li> </ul>
Connect over	Wi-Fi, infrared
Display	Smart phone or tablet
Features	<ul style="list-style-type: none"> <li>• Voice or app-based control and scheduling</li> <li>• Easily monitors and controls the Air Conditioner at anytime and from anywhere</li> <li>• Can control smart blinds and detect air leakage</li> <li>• 20% - 25% energy savings over conventional AC</li> </ul>



# Technology Mapping – Smart appliance



Smart blinds	Smart Thermostats	Smart IAQ Devices
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Particular	Details
User interface	<ul style="list-style-type: none"> <li>• Touch: Manufacturer app</li> <li>• Voice: Alexa or google assistant</li> <li>• Dashboard on machine</li> </ul>
Connect over	Wi-Fi, infrared
Display	Smart phone or tablet
Features	<ul style="list-style-type: none"> <li>• Smart Sensors for low voltage usage and smart detergent dosage.</li> <li>• Multiple wash and dry options/program based on cloth type and how dirty cloths are.</li> <li>• Can be operated from anywhere</li> <li>• Smart selection of wash/dry program reduces wash time and energy consumption.</li> <li>• Wash program can be updated over the air same as any mobile apps</li> </ul>





# Technology Mapping – Smart appliance



Smart blinds	Smart Thermostats	Smart IAQ Devices
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Particular	Details
User interface	Touch: Manufacturer app Voice: Alexa or google assistant
Connect over	Wi-Fi
Display	In Build Display or smart phone or tablet
Features	<ul style="list-style-type: none"> <li>User can see inside refrigerator without opening door using cameras</li> <li>Can provide recipe ideas</li> <li>Order groceries</li> <li>Look up the weather</li> <li>Bluetooth speakers also let user stream music</li> <li>Can control other smart appliances such as geysers, AC etc</li> </ul>



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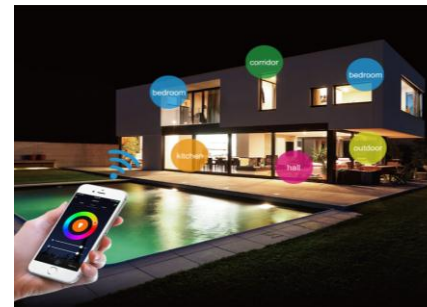
Particular	Details
User interface	Touch: Manufacturer app Voice: Alexa or google assistant
Connect over	Wi-Fi
Display	In Build Display or smart phone or tablet
Features	<ul style="list-style-type: none"> <li>User can set temperature and schedule the geyser using app or touch panel</li> <li>User can monitor and control geyser from any where</li> <li>Can monitor user preference of temperature and keeps water ready at preferred temperature and preferred time</li> </ul>



# Technology Mapping – Smart appliance



Smart blinds	Smart Thermostats	Smart IAQ Devices
Smart AC	Smart Washing Machine	Smart Refrigerator
Smart Geysers	<b>Smart Lighting</b>	Energy Monitoring Systems



Particular	Details
User interface	Touch: Manufacturer app Voice: Alexa or google assistant or IFTTT or NEST or Apple Home
Connectivity	Wi-Fi, Bluetooth, ZigBee
Display	Smart phone or tablet
Features	<ul style="list-style-type: none"> <li>Option of multi level dimming is available.</li> <li>User can monitor and control light from anywhere using smart phone</li> <li>User can change light colour based on requirement</li> </ul>



# Technology Mapping – Smart appliance



Smart blinds	Smart Thermostats	Smart IAQ Devices
Smart AC	Smart Washing Machine	Smart Refrigerator
Smart Geysers	Smart Lighting	<b>Energy Monitoring Systems</b>

- Energy monitoring systems (EMS) are used to monitor the real time power consumption. Using the smartphone app, live alerts regarding usage of each appliance can be obtained.
- EMS allows to track energy consumption of appliances and track monthly energy statistics.
- Based on the feedback and analysis of the present and past energy consumption trends insights for energy saving may be identified.

## Types:

- Non-Intrusive Load Monitoring
- Intrusive Load Monitoring - Circuit level monitoring
- Intrusive Load Monitoring - Plug load monitoring



# Technology Mapping - Computing



In smart home automation systems, the computation is classified in two categories, this includes cloud computing and edge computing.

## Cloud computing

- It involves storage and maintenance of data over the Internet location.
- This **gives users the flexibility to have access to the data from any location on the planet.**
- In IoT based Home Automation systems, users can send commands to the hub even from a distant or remote location over the cloud network.
- The hub will further send the signal for the intended sensors to trigger and perform the user-requested action.
- Once the action is performed, the hub will update the status of the action taken to the cloud network and in this way, **users can control and monitor every aspect of their smart homes.**

## Major challenges of cloud computing



Latency issues and delays in the transfer of data.



High security risk of the data in flight and storage on remote servers



Privacy concern with complete information of smart home going outside



No functionality of the system in the event of Internet outage



Possibility of system rendered useless when the service provider stops support



# Technology Mapping – Computing



## EDGE Computing

- Edge Intelligence **brings data processing from the cloud to the field**, i.e. to the smart home where sensors, devices are deployed.
- The data collected from device is either processed at the device itself known as **edge analytics** or at the local node deployed at the periphery of home network known as **fog computing**.
- Only a subset of data is transmitted to remote server. Sensitive information can be processed at Edge allowing only non-sensitive information to be sent to server.

## Benefits of EDGE

### Security

Smart security systems including security cameras, video doorbells and alarms are sending data to fog node deployed in the home network

### Internet Connectivity, Bandwidth & Latency

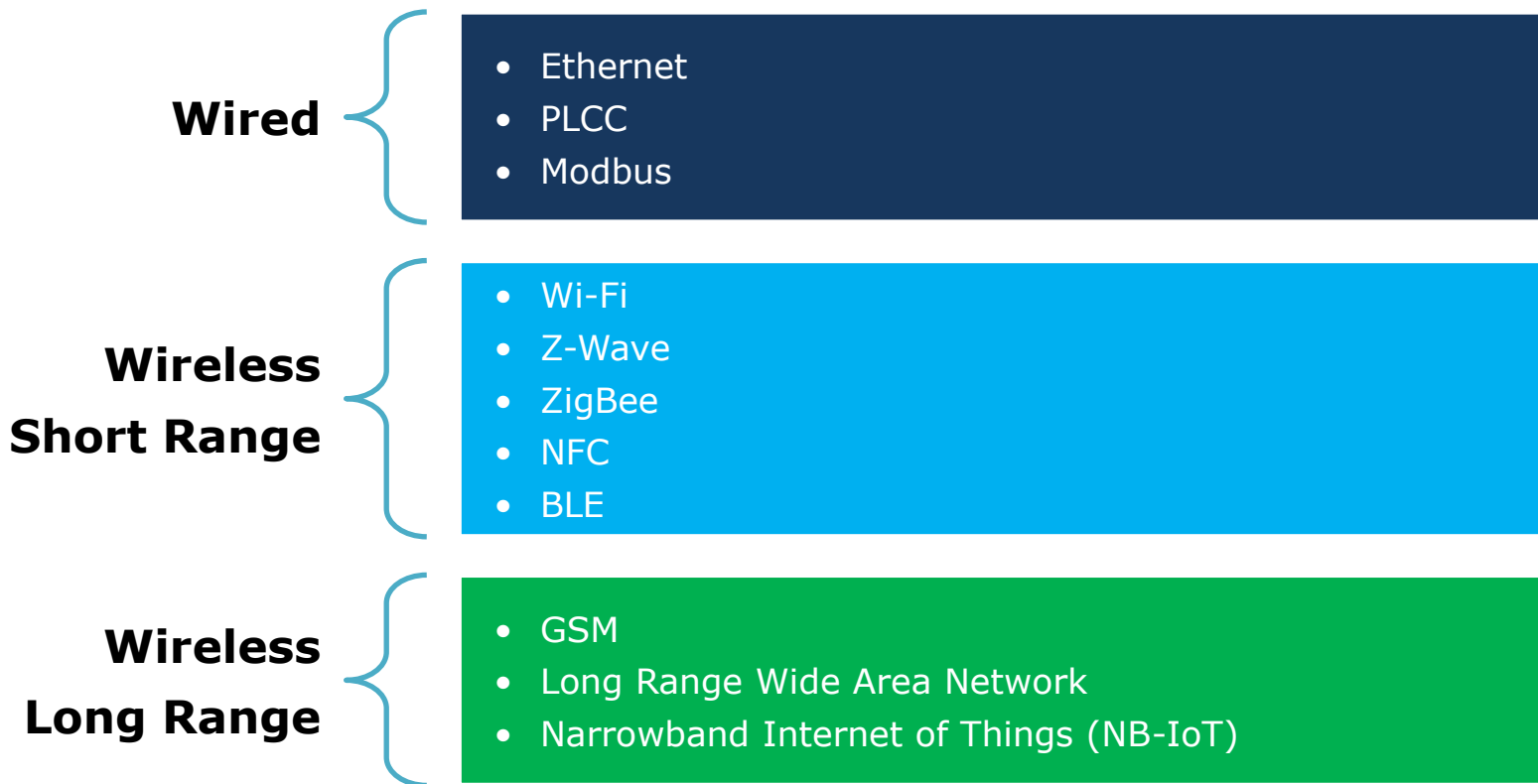
Smart video locks processing of the images and voice to open the door automatically even in network outage and avoiding network latency

### Privacy

Security cameras processing the images and voice recognition to detect unsolicited activity at the edge. **Ensuring private and sensitive data** from streams of camera or microphones do not leave the premises without consent.



## Communication





# Technology Mapping - Interface



## 1. App/dashboard-based user interface

- App/dashboard UI allows user to control, monitor and manage all the smart devices present in the home by using a tablet or smartphone.
- User can monitor past readings. User can schedule the various devices or write rules for different appliances.
- Controls can be performed remotely using mobile application.
- Examples : Apple home, google home, Samsung thing app, smart things etc.

## 2. Voice based user interface

- Voice UI allows user to control the devices by giving voice command.
- It is mostly used in the private places like homes, private cars and enclosed office. It enables the hands-free computing.
- For example, a user can adjust light, control temperature, or many other devices by giving commands without moving to manual control panels.
- Voice UI is based on NLP implementation and IOT.
- Example : ALEXA and google assistant based home automation devices.

## 3. Gesture based user interface

- Gesture UI allows user to control the devices by providing gesture.
- It provides remote less environment to the users.
- Gesture UI is generally based on computer vision (CV).
- For instance a user can adjust the lighting level or thermostat level by moving the hands.
- Examples : Ubiquilux, Nest thermostat (singlecue Gen 2), Piccolo, Otodo etc.





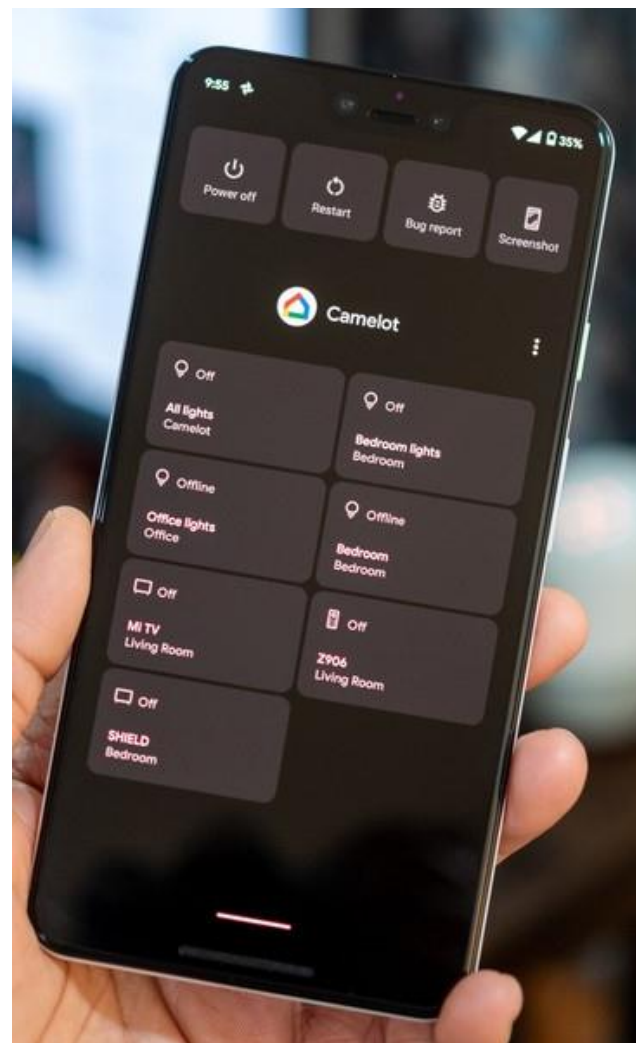
## Proprietary software

Proprietary software, also known as closed-source software, is a non-free computer software for which the software's publisher or another person retains intellectual property rights.

## Open source

These are computer software in which source code is released under a license in which the copyright holder grants users the right to study, change, and distribute the software to anyone and for any purpose.

**Current trend:** Android 11's power menu device controls finally bring the phone into the smart home





# Performance of Smart Home



## Factors affecting performance of smart home

### Type of intervention

- **Manual intervention:** Real time energy consumption data collected by sensors or smart appliances is provided to user and user controls the energy consuming devices based on received data or energy saving tips
- **Automatic intervention:** In such advanced home automation system, the hub or home energy management system monitors and controls energy consuming appliances to maintain preset value or parameters deduced from user preference and ambient conditions

### Level of controlling available

- Controlling options available such as turning on or off devices or fine tuning of operating parameters to make the device work more, or less efficiently.

### Design and operating efficiency of energy consuming system

- Quantum of energy saving will depend upon how much energy efficient system is installed in the house and how well it is maintained and operated.

### User preference

- Whether energy efficiency is a priority and there are robust algorithms to ensure energy efficiency in different situations or whether automation is based on user preferences with no or marginal consideration of energy efficiency.



# Performance of Smart Home



## Energy savings of smart home automation technologies

Technology	Benefit	Energy saving range
Smart thermostat	Heating and cooling can be switched on and off remotely and the temperature adjusted up and down	<ul style="list-style-type: none"> <li>• 5-10% for heating (Fraunhofer, 2016)</li> <li>• 8-16% for cooling (Fraunhofer, 2016)</li> <li>• 2-16% electricity (NEEP, 2015)</li> <li>• 5-22% gas (NEEP, 2015)</li> </ul>
Smart zoning	Allows individual rooms or zones to be heated or cooled to a specific temperature, at a specific time of day	<ul style="list-style-type: none"> <li>• 10% for heating or cooling (Fraunhofer, 2016)</li> </ul>
Smart window control	Controls the amount of light let through and can block heat or cold	<ul style="list-style-type: none"> <li>• 11-20% of heating or cooling (Fraunhofer, 2016)</li> </ul>
Occupancy based lighting	Sensors monitor room occupancy and turn on lighting when needed and turn it off when rooms are empty	<ul style="list-style-type: none"> <li>• 30-41% of lighting energy use (Fraunhofer, 2016)</li> </ul>
Smart lighting	Lighting that can be controlled remotely, automated, reacts to occupancy	<ul style="list-style-type: none"> <li>• 1-10% of whole home energy use (NEEP, 2015)</li> </ul>
Smart plugs	Turn an unconnected product into a connected one, enabling customers to receive some of the functionalities offered by smart appliances with existing, traditional appliances at a much lower cost	<ul style="list-style-type: none"> <li>• 1 - 4.6% of whole home energy use (NEEP, 2015)</li> </ul>



# Performance of Smart Home



## Energy savings of smart home automation technologies

Technology	Benefit	Energy saving range
Home energy monitoring system	Provides energy consumers with information about how they use energy in the home and/or prompts to modify consumption.	<ul style="list-style-type: none"> <li>4-7% of whole home energy use (PG&amp;E, 2015)</li> </ul>
Energy portal	A type of home energy monitoring system that is linked to a web-based platform which provides information on energy use and suggestions on how to improve efficiency.	<ul style="list-style-type: none"> <li>5.7% - 7.4% electricity (NEEP, 2015)</li> <li>5.7% - 13% gas (NEEP, 2015)</li> </ul>
Home energy monitoring system plus dynamic pricing	Provides energy consumers with information about how they use energy in the home and/or prompts to modify consumption connected to a demand response programme that gives incentive via electricity tariffs to reduce energy use.	<ul style="list-style-type: none"> <li>8-22% electricity (NEEP, 2015)</li> <li>8-22% gas (NEEP, 2015)</li> </ul>
Home energy management system	Provides the household (or third parties) the ability to control energy-consuming processes in the home, either remotely via a smart phone or web service or based on a set of rules, which can be scheduled or optimized based on user behavior.	<ul style="list-style-type: none"> <li>7.8% of whole home energy use (van Dam, 2013)</li> <li>20% of whole home energy use (Bhati, et al., 2017)</li> </ul>
Smart home	Combination of smart home technologies that provide measurement, monitoring, information displays, management, control, automation, zoning, occupancy systems, etc.	<ul style="list-style-type: none"> <li>27% of whole home energy use (BPIE, 2017a)</li> </ul>



# Recap and Takeaway



- The smart home technology space is evolving at a rapid pace and innovative business offerings (products as well as services) are being developed to make the technology user friendly
- Global alliance and forums are being created to promote standardization and interoperability
- Energy saving potential of smart home, that includes devices that provide measurement, monitoring, information displays, management, control, automation, zoning, occupancy systems, etc. is estimated as 27%
- Availability of smart home technologies are making homes demand response (DR) ready, which may help utilities in developing and executing large scale DR program
- Installation of smart meters, which is being undertaken at large scale across the country, will provide much needed time of day (ToD) metering provision to residential sector and may provide a fresh push to demand of smart home products and services



# Thank you



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Knowledge Partner

# Deloitte.