An Integrated System to support Internet of Things (IoT) in a Smart Home

Solution for Group Assignment Phase 1

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Provided by Group 6

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Abstract / Introduction

This paper describes the architecture for a system for a smart home. It is a submission of the assignment "**An Integrated System to support Internet of Things (IoT) in a Smart Home".** In the following we will focus on some of the requirements mentioned, and some changes have been made.

In the smart home there are sensors in the refrigerator and in the locks on the outer doors. The sensors in the refrigerator make reports about changes in the number of tagged items. Shopping lists are updated in case some items are missing. The sensors in the locks are reporting the status of the lock.

Movement sensors report intrusion alarm to the system in case of unexpected activity in the house.

Web cameras are regularly sending visuals to the system.

The different things that are reported to the system, can be accessed by apps from mobile devices. Apps can look up data. An app must be logged on. Each logon relates to a home.

The TV has a censor. An attempt to turn on the TV sends a request to the system. Access to the TV will be granted or denied based to the time of day.

The garage door is password operated, and also sends a request to the system. Access will be granted or denied.

User stories

Check shopping list

Update shopping list

Synchronize shopping list

Open garage door (with password)

Start cameras

Stop cameras

Check door status

Call the police when intrusion alarm

Functional Requirements

Personas

<table>
<tr>
<td>John

<table><tr><td></td><td>Security</td></tr><tr><td></td><td>Reliability</td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table></td>
<td>John is the father of two children. He is a Microsoft employee. John wants the home to be interactive. He wants to be able to monitor the home when no one is there. Cameras must keep the front door under surveillance, and the rooms in the house must be visible.

User Stories
At the office John takes one of his portable devices, and gets a visual of the front door.
Also at the office, he checks the status of the censors. Fire alarms, intrusion alarms, locks on doors and windows.
In case of intrusions, he is notified by one of his handheld devices.
He is notified in case of power failure (he can then check whether the backup power starts up).</td>
</tr>
<tr>
<td>Jane

<table><tr><td></td><td>Reliability</td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table></td>
<td>Jane is the mother of two children. She is a dentist. She wants the family to feel safe in the home.

She often does the shopping. She uses handheld devices such as a smart phone.
She is responsible for paying the bills for electricity and water.

User Stories
Jane checks whether new items have been added to the shopping lists. She can see the lists on one of her handheld devices.
She checks the mail box.</td>
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<tr><td></td><td>

- She gets the status of the meters for water and electricity consumption.

</td></tr>
<tr><td>Emma

<table><tr><td></td><td>Reliability</td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table></td><td>Emma is 10 years old. Bedtime is nine o' clock. Emma is getting up at seven in the morning to go to school. She will be back about three o' clock. She can access her own room. She does not have access to the tool shed, store room, garage. She likes to play games on the computer, which she plays during the evening.

Dinner is six o' clock.

User Stories

- She needs to able turn on the TV between four and six.
- She also wants to be able to play computer games four to six.

</td></tr>
<tr><td>Thomas

<table><tr><td></td><td>Reliability</td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table></td><td>Thomas is eight years old. Bedtime is nine o' clock. Thomas also comes home about three. He spends the afternoon in very much the same way as his sister.

User Stories

- Like his sister, he wants to be able to watch TV in the hours four to six.
- Computer games must also be accessible in these hours

</td></tr>
<tr><td>Peter
<table><tr><td></td><td>Reliability</td></tr><tr><td></td><td>Security</td></tr><tr><td></td><td>Data Confidentiality</td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table></td><td>Peter is 45 years old. He works at OverSee's Insurance. The insurance company have a system that home systems can report to. Fire, flooding, and intrusion are among the reports they get. Peter is responsible for making regular reports from the log system. Once a month there will be sent bills for false alarms.

User Stories
He needs to run a program that selects all the false alarms. The false alarms will go to the finance department, so they can send out bills.</td></tr>
<tr><td>Lisa
<table><tr><td></td><td>Reliability</td></tr><tr><td></td><td>Security</td></tr><tr><td></td><td>Data Confidentiality</td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table></td><td>Lisa is 35 years old. She works at the Fire Department. Several home systems report alarms to the department. There is a monitoring system at her end. All the home systems must be interfacing with the monitoring system.
Incoming alarms must be acted upon if they don't stop within a set period of time.

User Stories
She must be able to receive an alarm, and send out fire trucks.</td></tr>
</table>

Scenarios

Scenario	Rationale
The refrigerator must update the electronic shopping lists.	The shopping list on portable devices can be synchronized.
Censors that check whether doors and windows are locked.	This proves that the system responds and is sending feedback.
Malfunction detection on doors.	To check for unlocked doors or intrusion.
Cameras to cover every corner of the house.	Security. Surveillance.
The garage door must be password operated.	The garage door must only be opened by John and Jane.
The system must be able to access meters. Water and electricity consumption.	Expenditure management. Also to detect consumption that looks suspicious.
Intrusion alarm.	Security.
Their mailbox has a censor. It checks whether something is thrown in.	It saves time not to have to open the mailbox.

Design Decisions

Concern (Identifier: Description)		How to make sure the system is up and running 24/7?
Ranking criteria (Identifier: Name)		Reliability
Options	Identifier: Name	A cloud solution.
	Description	If anything happens to the house – flooding, power failure for example – the system will still be running and able to report what has happened. A cloud solution also ensures, that the system will be safe in case of intrusion.

	Status	This has been decided.
	Relationship(s)	
	Evaluation	Reliability is achieved by the cloud solution being safe from disturbances like the ones mentioned above. The system is also being by professionals who have all the infrastructure and platforms for creating a sage environment.
	Rationale of decision	The cloud solution ensures that the system is kept safe from outside factors. This helps keep the system running.

Concern (Identifier: Description)		It needs to be a distributed system, accessible from portable devices. How to structure the distributed software system with decoupled components that interact with remote services?
Ranking criteria (Identifier: Name)		1. Separation of concerns 2.
Options	Identifier: Name	The Broker Architectural Pattern
	Description	This is a distributed software system. Several smart homes will be accessing the system. This happens mainly via apps on portable devices.
	Status	This option has been decided.
	Relationship(s)	
	Evaluation	The system can be accessed by many devices because it is distributed.
	Rationale of decision	Information is sent from devices in the home to the services in the application. Apps on portable devices can then request this data.

Concern (Identifier: Description)		Different homes must only be able to see their own data.
Ranking criteria (Identifier: Name)		1. Authenticity 2. Confidentiality
Options	Identifier: Name	The Proxy Design Pattern
	Description	
	Status	
	Relationship(s)	
	Evaluation	When data is accessed by a home, the system must make sure that it only exposes data for that particular home.
	Rationale of decision	

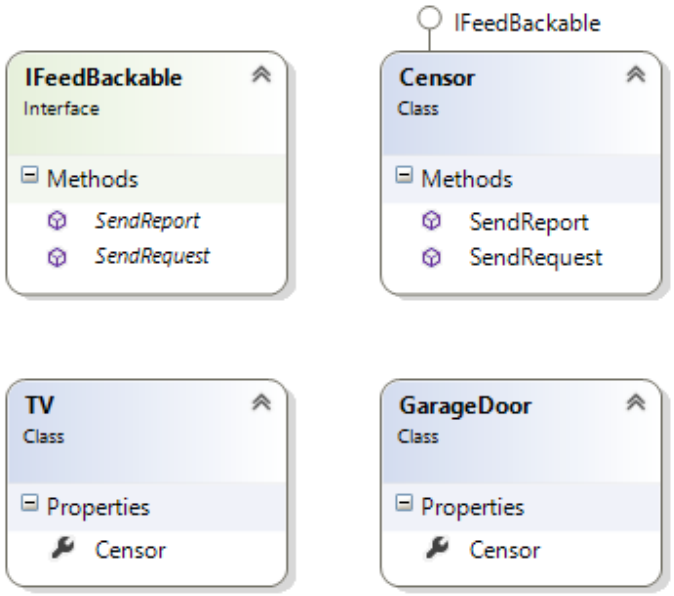
Concern (Identifier: Description)	How to ensure a good architecture for interactivity?

		1.
Ranking criteria (Identifier: Name)		2. Separation of concerns 3. Maintainability 4. Extensibility
Options	Identifier: Name	Model View Controller (MVC) Architectural Pattern
	Description	Applications with interactive user interfaces might be getting updates concerning the user interface. This should happen without consequences for the rest of the system.
	Status	Decided.
	Relationship(s)	The Broker Pattern was decided upon with regard to data communication. The controller part of the MVC structure is going to communicate with the Broker.
	Evaluation	Separation of concerns is achieved by an architecture that separates the functionality of 1. user Interface 2. input handling 3. communication with the services
	Rationale of decision	This architecture is decided because it satisfies the need for maintainability and extensibility.

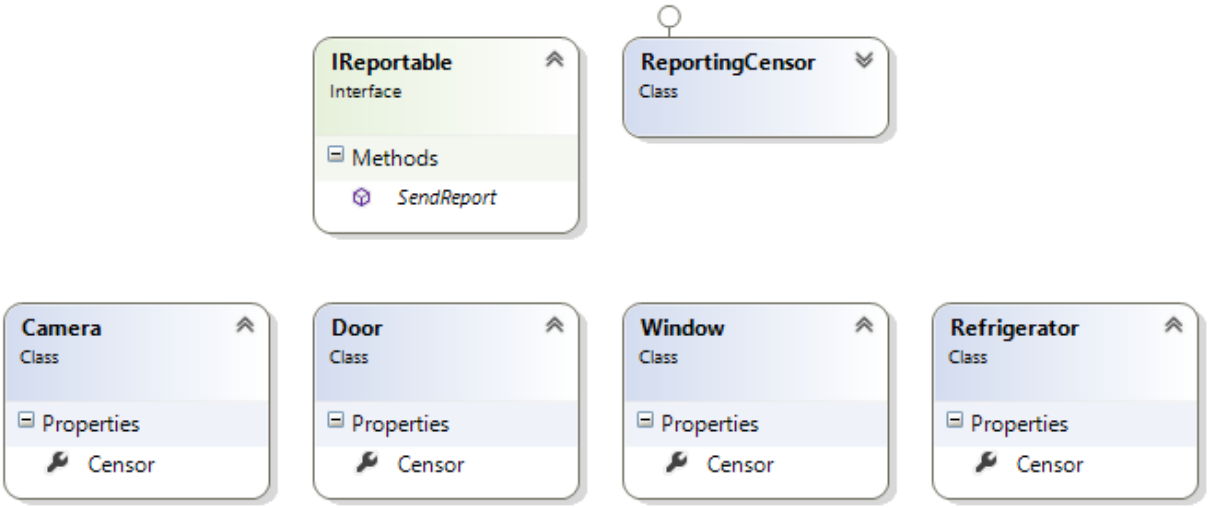
Architecture Diagrams (4+1 view)

Logical View

The devices ind the house is presented by 2 interfaces and 6 classes.



The TV and the Garage Door each has a censor that can send reports to the system and receive an answer.



The cameras, doors, windows, and refrigerator each has a censor that can only send reports.

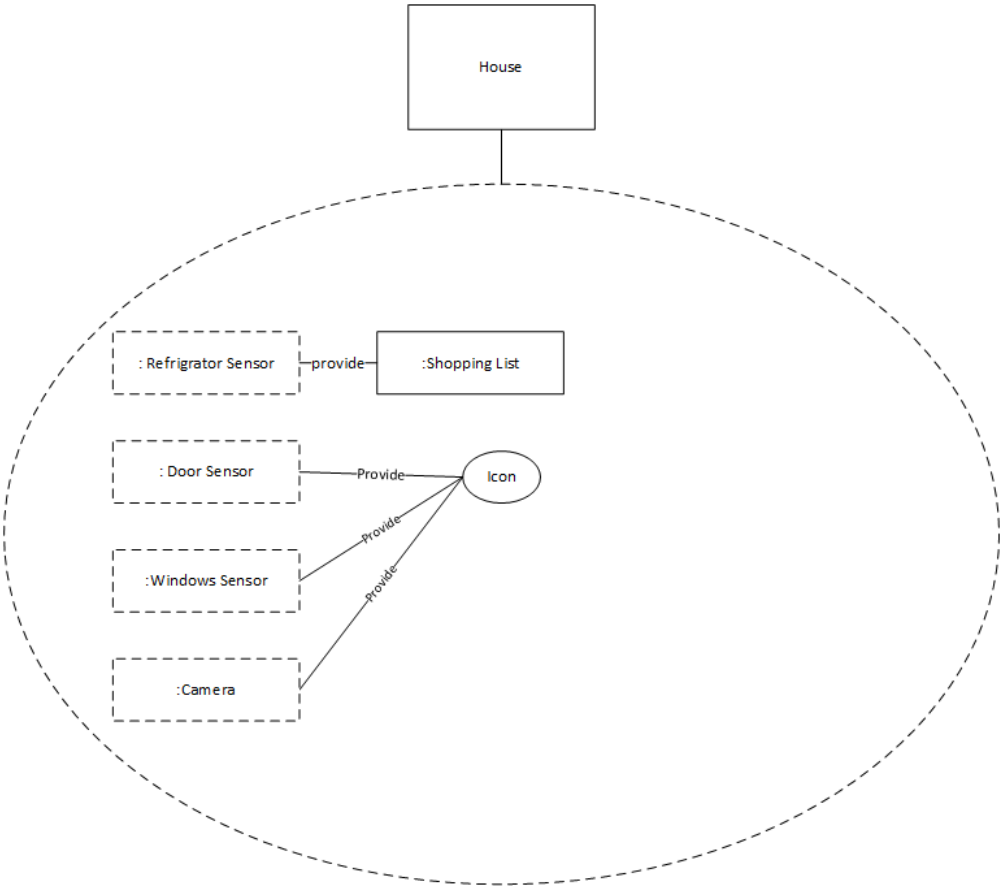
MVC Pattern (apps)

The apps are interacting with the system via the MVC Pattern. The user interface in the app communicates with a controller. The controller relays data between the Broker in the system and the controller.

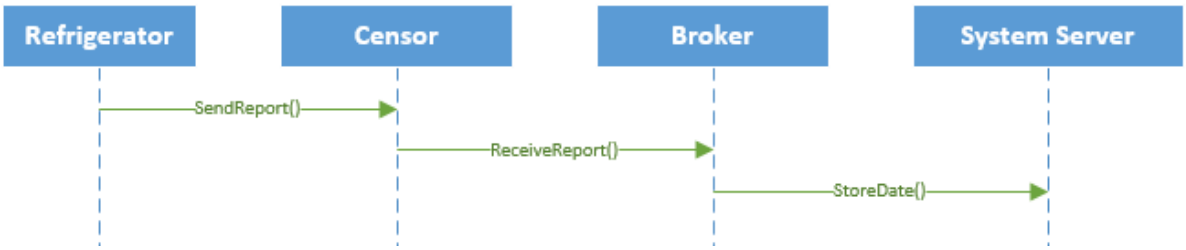
Broker Pattern (The Smart Home System in the Cloud)

Development view

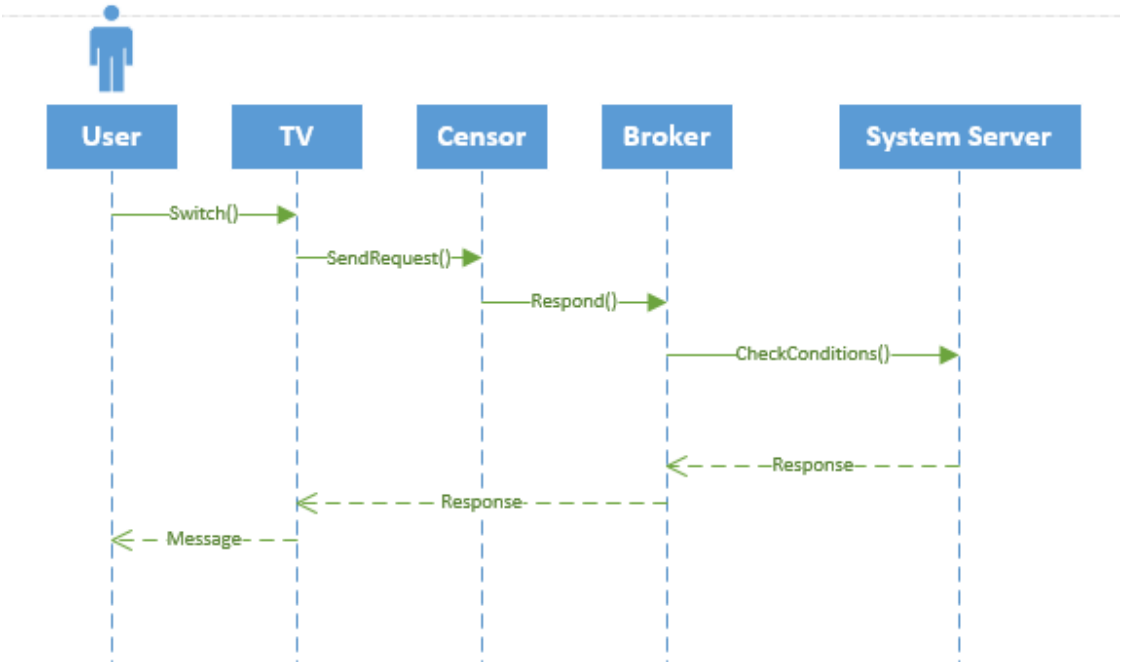
Here we see the service architecture.



Process View



A refrigerator only sends a report.

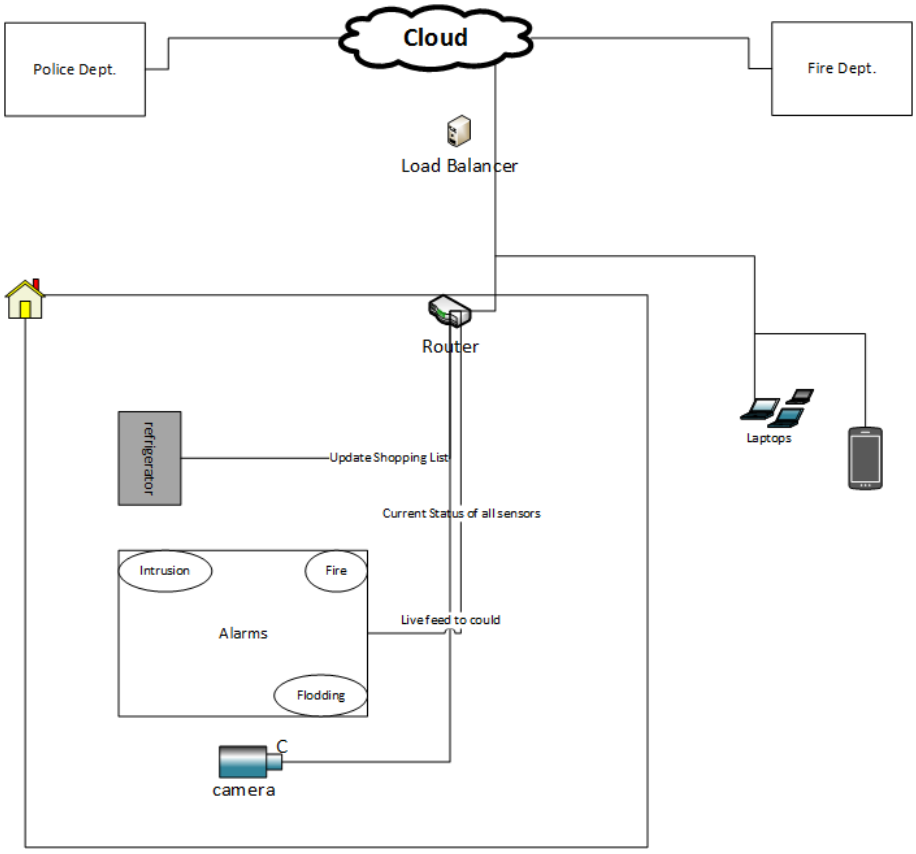


A TV sends a request and the user will be granted or denied access to the TV.

Physical View

The system is deployed as a cloud solution. There are three main parts.

1. The house with devices and sensors
2. Insurance, Police and Fire Department (2 of them is shown below)
3. Apps on portable devices accessing data in the system.



Scenarios