

# Configuring Devices as End-User Programming in the Era of Internet of Things

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**Abstract.** In the era of Internet of Things (IoT), configuring how one's own devices work together is very similar to programming by the end user. This is challenging to most users and may also pose a challenge to the growth of popularity of IoT. One possible solution is to facilitates prosocial behavior and enhance collaboration between users.

## 1 Introduction

In the days of Internet of Things (IoT), every device communicates with each other. Potentially, each unit of 'things' or devices should have some intelligence that can work on its own, talk to other units, and adjust its own work based on information from other units. One obvious way for manufacturers to allow users to configure these devices without going into the technical details is to provide different 'workmodes' for the user to choose from. The user only needs to set the devices to different modes. As number of devices one person owns increases, the number of possible combinations of different modes increases drastically and such configuration becomes a challenge that is similar to end-user programming. This makes configuration of devices a challenging task. One possible way to enhance the popularity of Internet of Things is to offer community-supported platforms

that allow users to share their ‘recipes,’ ‘success stories,’ and solutions to commonly-faced problems.

## 2 Configuration as End-User Programming

Website ‘If This Then That’ (IFTTT) (<https://ifttt.com/>) allows users to configure how the website server should respond to certain conditions. The website server detects events in many different channels, such as Facebook or email. The user can configure the IF part in the rule to specify the event when the rule should be triggered, e.g., ‘IF someone tag me on Facebook.’ Then the user configures the ‘THEN’ part, such as sending an SMS to one’s own mobile phone. This is the simplest form of end-user programming. Imagine in the era of IoT, an owners need to configure his/her devices and how these devices work with each other. Such configuration is an end-user programming task.

In the era of IoT, Each unit in a network of devices may offer different 'work modes' for the users to choose. Regular users do not actually program each of them. Instead, they need to choose among the several modes for each unit. For example, your lock at front door talks to the air-conditioner and coffee machine. Whenever there is someone coming back home, the air-conditioner adjusts itself to make sure that the temperature is comfortable (based on its communication with a thermostat or weather website). Coffee machine prepares suitable kind of coffee, depending the amount of milk the refrigerator tells it. Each of these devices has their own intelligence in adjusting their functions depending on their states and information from other devices. However, the user needs to preconfigure how these devices work on its own. For example, the user needs to configure the coffee machine such that it prepares coffee based on the availability of milk. It could have another mode to make coffee based on the weather. Imagine each of 10 appliances in a household kitchen has 3 different working modes. There are  $3^{10} = 59,049$  ways to configure them. This 'configuration process' itself is a programming task needed to be done by regular users.

## 3 Prosocial behaviour in Growth of IoT

One feature in IFTTT website is that people can share 'recipes' –some existing set of configures about the events and responses. This definitely helps new users of the service to get started using it without being frustrated at trying out different combinations. This can save the effort in trying out new things. In order for Internet of Things to be easily adopted by the mass, social elements need to be built in. There are at least three types of social elements that would encourage the adoption of 'Internet of Things': sharing resources, demonstration, and helping in

problems. Tech-savvy users can share their ‘recipes,’ or templates of configuring a set of devices on a public websites. So that new users can copy and easily get going with their new devices. This eases the burden of regular users in thinking about how to ‘program’ their network of devices. A sharing platform should also allow existing users to share success stories, simply demonstration of different configuration of a set of devices. To people who are considering whether to acquire IoT devices, such visualization of any benefits can encourage them make purchase decisions. A collaborative platform can also help users to solve their problems faced in programming their network devices. With crowdsourcing mechanism, users can post their questions on such platform and other users can assist them. This is much more effective than static ‘FAQ’ sections because users can receive specific assistance to problems specific to themselves.

