

POLITECNICO DI TORINO

## PhD in Computer and Control Engineering

Supervisor Prof. Fulvio Corno

Dipartimento di Automatica e Informatica

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# Architectures for IoT Notifications: from disruption to benefit

PhD Candidate:

Teodoro Montanaro

# **1.Introduction**

The importance of notifications in our daily lives is growing. However, their presence is not always perceived as a benefit by users: various factors influence the reaction and the disruption of recipients.

# 4. XDN framework



## 2.Goal

The main goal of the present work regards the design and the development of new IoT architectures able to enhance user experience with IoT notifications, reducing disruption caused by them.

Two different approaches were adopted

1. At the **distribution level**: notifications are intercepted and then systems decide if, when, and how to show them

## Result: Smart Notification System [1]

 at the design level: notifications are designed with the aim of reducing user disruption.
 Result: XDN framework [2]

# **3. Smart Notification System**



#### Fig. 2: Architecture of the XDN framework

The XDN (Cross Device Notification) framework (Fig. 2) aims at **assisting developers in designing, implementing and testing** personalized **notifications** to be distributed among ad-hoc networks of IoT/mobile devices using a **cross-device** approach.

f Load code Save code Run code	Device set	Notification sets 🖶
	Portfolio: 🕁 Status: 🕁 🛛 Load	Notifications: Load
<pre>xdn.notification.onNotification(myNotification) * { </pre>	scenario1 • scenario1-status •	safetyGrandma 🔻 🔇
<pre>var content = myllotification.content; var generator = myllotification.generator; if(generator.toLowerCase().includes('@dangerous'))</pre>	List of all available devices	List of notifications
<pre>{     xdn.device.select('isAvailable=true').select('deviceType=="smartLight").changeColor('red').on();     xdn.device.select('isAvailable=true').select('deviceType=="smartLight").show(content).ring("ring.mp2",-1);     xdn.device.select('isAvailable=true').select('deviceType=="smartphone").vibrate().show(content).ring("ring.mp3",-1);     xdn.device.select('isAvailable=true').select('deviceType=="smartphone").vibrate().show(content).ring("ring.mp3",-1);     xdn.device.select('isAvailable=true').select('deviceType=="smartphone").vibrate().show(content).ring("ring.mp3",-1);     xdn.device.select('isAvailable=true').select('deviceType=="tablet").vibrate().show(content).ring("ring.mp3",-1);     xdn.device.select('isAvailable=true').select('deviceType=="smartphone").vibrate().show(content).ring("ring.mp3",-1);     xdn.device.select('isAvailable=true').select('deviceType=="smartphone").select('deviceType=="smartphone").selectWith('speak     if (smartphonesPlayingSound = xdn.device.select('isAvailable=true').select('deviceType=="smartphone").vibrate().show(content).ring("warn.mp3",-1);     xdn.device.select('isAvailable=true').select('deviceType=="smartphone").vibrate().show(content).ring("warn.mp3",-1);     xdn.device.select('isAvailable=true').select('deviceType=="smartphone").vibrate().show(content).ring("warn.mp3",-1);     xdn.device.select('isAvailable=true').select('deviceType=="smartphone").vibrate().show(content).ring("warn.mp3",-1);     xdn.device.select('isAvailable=true').select('deviceType=="smartphone").vibrate().show(content).ring("warn.mp3",-1);     xdn.device.select('isAvailable=true').select('deviceType=="smartphone").vibrate().show(content).ring("warn.mp3",-1);     xdn.device.select('isAvailable=true').select('deviceType=="smartphone").vibrate().show(content).ring("warn.mp3",-1);     }     else</pre>	smartphoneName: iPhone 6is available: trueDisplay: lockedSpeaker:Volume: 0-0-0 0Status: off playing off playingLight:Status: offIntensity: 0Color:Available colors: +Current color: none red red	Notification n. 1 - Content: It is not necessary to reach your grandma date Time: 2017-04- 12T16:27:55+02:00 Generator: safetyGrandma@warning Icon: none - Notification n. 2 - Content: Hurry up: your mother fr date Time: 2017-04- 12T16:28:37+02:00 Generator: safetyGrandma@dangerous Icon: none Icon: Note Icon: none Icon: none Icon: Note Icon: I
<pre>8 * {     var smartphonesWithDisplayOn = xdn.device.select('isAvailable==true').select('deviceType=="smartphone"').select('display.     if (smartphonesWithDisplayOn.length() &gt;= 1)     {         xdn.device.select('isAvailable==true').select('deviceType=="smartphone"').show(content);     }     elce     sumg Fridge 13 18:13:23.098 The following devices were selected with eselector 'deviceType=="smartwatch":         Clear log 13 18:13:23.099 Message shown on smartwatch 'LG W150': The body temperature is 36.5 13 18:13:25.077 The sound has finished, so the speaker on smartphone(iPhone 6) is now again off and the volume was set as it was     fore the action 13 18:13:25.089 The vibration of the smartwatch(LG W150) was just stopped 13 18:13:25.089 The sound has finished, so the speaker on smartwatch(LG W150) is now again off and the volume was set as it was </pre>	Frequency: 0 Vibration: off on off tablet Name: Samsung Galaxy Tab A is available: true Display: on Speaker: Volume: 50 Status: playing Light: Status: off	- Notification n. 3 - Content: The body temperature i 36.5 dateTime: 2017-04- 12T16:29:21+02:00 Generator: safetyGrandma@sile Icon: none

Fig. 3: Screenshot of the XDN GUI

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#### Fig. 1: Architecture of the Smart Notification System

The proposed Smart Notification System (Fig. 1) uses **machine learning algorithms** (Decision Tree, Naïve Bayes and SVM) to adequately manage incoming notifications. According to context awareness and user habits, the system decides:

- a) **who** should receive an incoming notification;
- b) what is the best moment to show the notification to the chosen user(s);
- c) on which device(s) the chosen user(s) should receive the notification;
- d) which is the **best way** to notify the incoming notification.

### 5. Results and conclusions

Both frameworks were tested within realistic scenarios: the analysis of the assessment demonstrates that both solutions are promising technologies.

## 6. References

- Corno, Fulvio; De Russis, Luigi; Montanaro, Teodoro (2015) A Context and User Aware Smart Notification System. In: IEEE 2nd World Forum on Internet of Things (WF-IoT), Milan, Italy, 14-16 December 2015. pp. 645-651
- Corno, Fulvio; De Russis, Luigi; Montanaro, Teodoro (2017) XDN: Cross-Device Framework for Custom Notifications Management. In: The 9th ACM SIGCHI Symposium on Engineering Interactive Computing Systems, Lisbon (Portugal), June 26-29, 2017. pp. 57-62