

User self-help module for a device management cloud based on the TR-069 Protocol

Norbert Nemet, Saša Radovanović, Mića Ćetković

RT-RK Institute for Computer Based Systems

Novi Sad, Serbia

{norbert.nemet, sasa.radovanovic, mica.cetkovic}@rt-rk.com

Nikola Ikonić, Milan Z. Bjelica

Faculty of technical Sciences, University of Novi Sad

Novi Sad, Serbia

{nikola.ikonic, milan.bjelica}@rt-rk.com

Abstract—In this paper, a solution for a self-help module as a part of a Device Cloud platform for connected consumer electronic devices is presented. The proposed solution allows users to track parameter values and solve issues on their devices. Contribution to technology is a real-time issue solving mechanism based on cross-referencing of parameter values and predefined actions for specific device types.

Index Terms—Internet of Things, device management cloud, self-support, device troubleshooting, TR-069.

I. INTRODUCTION

The development of Internet of Things (IoT) addressed the issue of real-time access to consumer electronic devices. This concept introduced inter-connection of devices and possibility of accessing devices through the Internet. Using this concept, Cloud-based solutions allow device managing and controlling, regardless of their location. Device Cloud (DC) platforms appear as tools for connecting devices to a wide spectrum of third-party applications, granting end-users to access their devices anytime and anywhere.

In this paper, a concept and implementation of an adaptive Self-help module (SHM) for end-users of consumer electronic devices is given. This solution tackles the serious issue of problem solving on end-user devices, allowing owners to initiate actions without having to contact the manufacturer or service provider. SHM uses straight-forward API to communicate with the DC core and web applications. The SHM is independent from the communication protocol between the DC and the end devices, but requires access to real-time parameter values.

II. RELATED WORK

Connecting consumer electronic devices to the Internet and other networks is a subject of modern research. The basic concept of these networks is proposed in [1]. Access to the connected devices can be provided in different ways. The concept of the user directly connecting to the devices is discussed in [2]. Another option is to use a cloud framework for device management. Some studies focus on frameworks for specific types of devices, e.g. portable devices [3], home automation systems [4], set-top boxes (STBs) [5]. These solutions are all restricted on providing device management services, either for network operators or end-users. Other systems provide support for all types of devices and are accessible by end-users and network operators [6]. A system for agile collection and diagnostics of device parameters is

discussed in [7]. To the best of our knowledge, there are no remote device management frameworks that allow access to connected devices for end-users with real-time diagnostic and automated issue management features.

III. SYSTEM ARCHITECTURE

The placement of the SHM module within a DC framework is shown in Fig. 1. The SHM module provides tools for users to access their devices by working as a part of the DC framework. Its plugin-like design allows it to easily connect with the rest of the system by binding to the DC's device and user management web services.

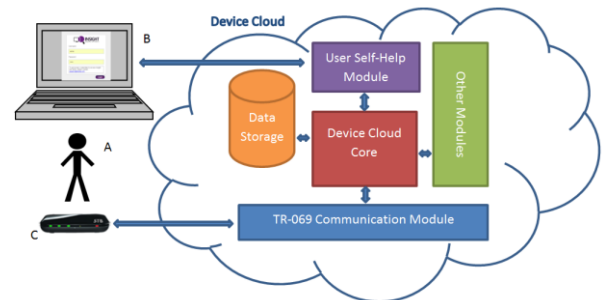


Figure 1. The usage environment. A- end user; B- web frontend; C- end device.

The SHM architecture consists of three major segments. The core of the SHM system is the *Self-Help Portal Logic* (SHPL) implemented as an enterprise java bean. The *Permission Manager* (PM) controls authentication, privacy and user roles in the system. Direct interaction between user and the system is achieved using the *Web-frontend* (W-FE). The top level architecture of the SHM inside the DC is shown in Fig. 2.

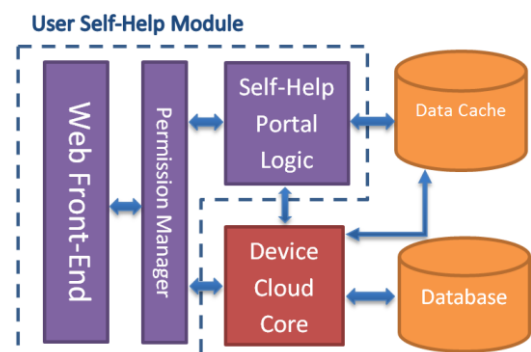


Figure 2. Architecture of the Self-Help Module with the Device Cloud Core and Data Storages

The SHM interacts with the DC using SHPL and PM modules. The DC has to provide basic device management operations and database access for the SHPL, as well as a connection point for end devices through the TR-069 protocol. The role of the *Web-frontend* is to expose the SHM's features to end-users and operators. It is designed to fulfill the needs of both types of users, these being simplicity, usability and comprehensive data representation. The PM acts as a proxy for the *Web-frontend* towards the DC's core functions and the SHPL. Following the predefined rules, it gives logged in users access only to features they are allowed to use. Therefore, it ensures privacy between end-users and provides extensive access rights for operators.

The SHPL constantly analyzes device parameters to identify potential issues. It creates fix suggestions for possible problems on end devices based on a decision tree algorithm, which is continuously being updated based on the previous fix attempts. The On-the-fly analysis of parameter values is shown in Fig. 3.

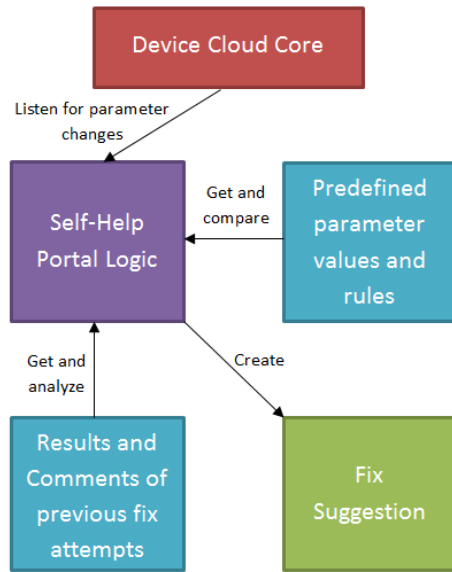


Figure 3. On-the-fly analysis of parameter values

An example of a fix suggestion in the *Web-frontend* is shown in Fig. 4. The frequency of this activity can be throttled by the DC Core if the system becomes overloaded. The creation of user accounts and login credentials for a device user is also part of the SHPL's features. This way, when the operator adds a new device user to the system, a new user account is created with an access only to devices of the newly created user.

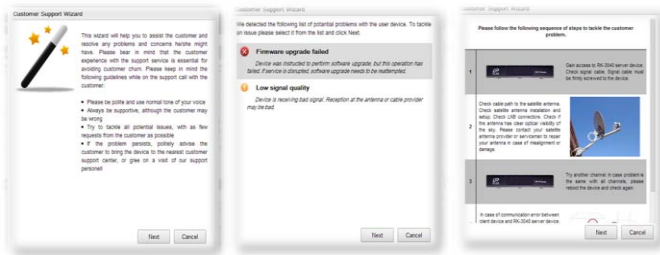


Figure 4. An example of a fix suggestion in the Web Front-End

IV. EVALUATION

The evaluation of our solution consisted of two comparisons. The first one was a feature comparison of the presented module and an existing Self Support Portal solution implemented by Friendly Technologies [6]. The results are shown in Table 1.

TABLE 1. COMPARISON OF FEATURES

Feature	Our SHM	Friendly Tech's SHM
Automated problem diagnosis and resolution	On-the-fly (real-time) diagnostics	On-demand only
Support for multiple device types	All existing + Custom data-models	All existing data-models
Device Network Map	✗	✓
Automated fix scripts	✓	✓

The comparison shows that the presented module has a more flexible architecture, although missing the Device Network Map feature.

The second test compared the average troubleshooting time of the presented SHM to that of the traditional call center as stated in [8]. We asked ten users to resolve three problems, each one on STB devices with the proposed SHM, while measuring the time needed to perform these operations. The addressed problems were:

- no channel available on the STB
- the device is not responding
- low signal quality

The results of the test are shown in Table 2.

TABLE 2. COMPARISON OF AVERAGE TROUBLESHOOTING TIMES

	Self-help portal	Customer support
Average troubleshooting time	8.3 min.	12 min.

The test showed that the presented SHM is more time-efficient by eliminating waiting time for a free operator and by giving more intuitive suggestions in form of pictures and animations.

V. CONCLUSION

In this paper, a solution for a self-help module as a part of a Device Cloud platform for connected consumer electronic devices was presented. The proposed solution allows users to track parameter values and solve issues on their devices. The evaluation showed that the presented module is competitive with existing solutions, while being more time-efficient. Future work will focus on extending the SHM's feature set and in depth evaluation and optimization of its parameter diagnostic algorithms.

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