INVENTION DISCLOSURE

1. **Invention Title.**

    Light Transport and Data Serialization for TR-069 Protocol

2. **Invention Summary.**
    This invention defines a light protocol stack for TR-069. Even though TR-069 is widely deployed, its protocol infrastructure is heavy compared to web standards used today. Alternative protocols and data representation will be beneficial for easier adoption in new breed of devices that fill the network.

3. **Invention Description**.

    a. **Describe the invention in detail.**

    Claims
    1. *Improve Device/ACS communication by using in addition to the TR-069 Notification and Connection Request messaging a websockets model for the request/response messaging used to manage the device, eliminating the TR-069 reverse HTTP dialog.*
        o *Use the existing TR-069 Notification mechanism to communicate the use of Websockets.*
            Advertise WebSocket Support (Inform Request)
            Reference WebSocket URL (Inform Response)
        o *This effectively separates Device Registration (Inform & Connection Request) from CPE/ACS management dialog.*
    2. *Usage of WebSockets*
        o *Encapsulate Request Types as WebSocket Tokens. This eliminates the need for SOAP as the encapsulation mechanism. Furthermore, instead of Websocket Tokens, e.g., a STOMP client as a consumer can be used as a layer on top of the Websocket to handle transactions, much more simpler and powerful than the SOAP. However, it is still possible to keep the SOAP layer on top of the Websocket e.g., to make a minimal change in an existing implementation.*
        o *Encapsulate Data Request/Response in JSON format or current TR-069 XML.*
        o *Defines private and public channels in order to better scale data distribution*
            ▪ *Private Channels used for Configuration and Monitoring*
            ▪ *Public Channels used for ACS to communicate common policies to a group of devices.*
            ▪ *WebSockets can be seen as a southbound adapter to a general bus architecture for device access*
            ▪ *The WebSockets can be seen as a southbound adapter to a general bus architecture for device access*

    Claims Discussion

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Claim 1:
   TR-069 protocol conversation is done in two ways:
   o *CPE Initiated Dialog (Notification Request Response) See figure 1*
   o *ACS Initiated Dialog (Connection Request) See Figure 2*
The CPE Initiated dialog occurs at boot time and at a scheduled or periodic interval if configured. During the Notification time the ACS has the opportunity to request information to the device and performs other management operations.

The ACS Initiated Dialog consist of an ACS HTTP GET send to the device that triggers the Notification process, falling back to the previously described procedure
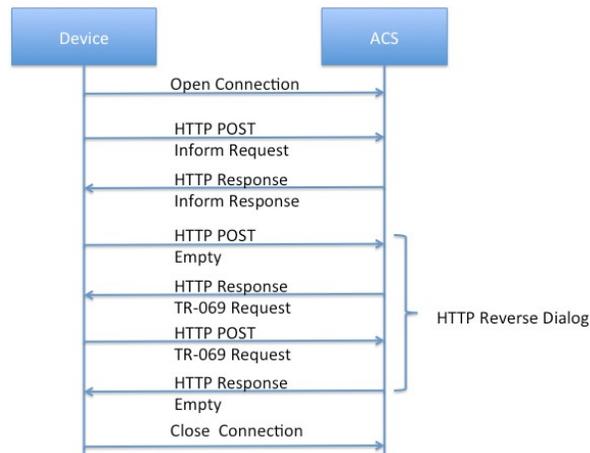
Figure 1 Device Initialization/Scheduled/Periodic Inform Connection
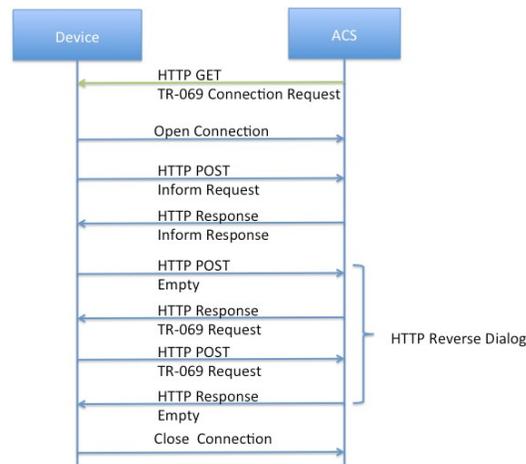
Figure 2 ACS initiated Connection

By Using Websockets, the Device/ACS communication stays over a lighter connection (WebSockets have much less overhead than HTTP) and fixes the TR-069 reverse HTTP model), being able to use regular websockets frameworks (including RPC request/response patterns). Today Implementers need to adapt HTTP frameworks to support the TR-069

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reverse dialog model. The aggregate effect is faster connections, less resources and comparatively similar scalability as the current HTTP model.

In Figure 3 The device initiates a HTTP connection, the regular TR-069 inform messaging exchange. After authentication, The WebSocket Information is made available to the device. The device opens the WebSocket Connection and maintains it alive. The HTTP session can remain open or closed and the Websocket now handles the exchange of information. This will normally happen at boot time or at periodic/scheduled inform, preserving the TR-069 state model.
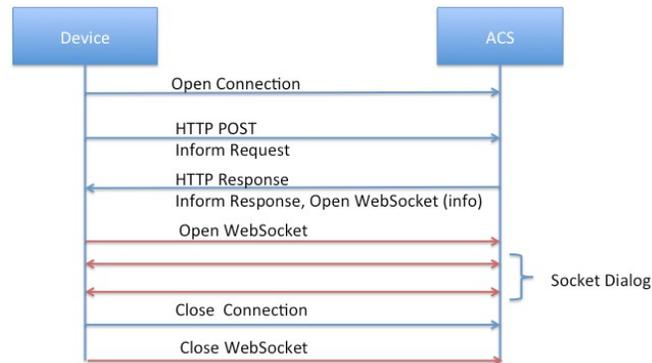
Figure 3 Device Initiated WebSocket

In figure 4 the same TR-069 Connection Request is used to trigger the WebSocket Connection (in case the websocket connection is closed). This mode of operation is also compatible with the existing mode of operation.
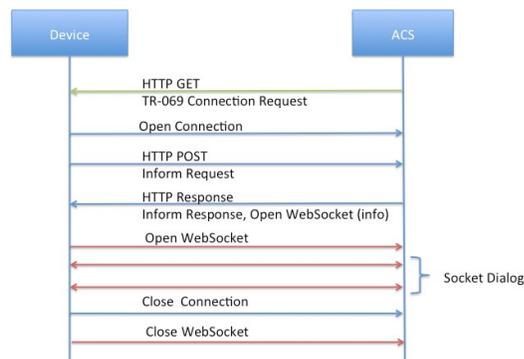
Figure 4 ACS initiated websocket

Claim 2:

TR-069, provides a point-to-multi-point communication model (ACS to one or more devices). A northbound interface is needed to communicate from external systems though the ACS. The SNMP Model used in Cable is more flexible as it is multipoint-to-multipoint fashion but lacks of control besides read/write access is possible

Using webSockets channels some interesting configurations can be achieved.
- o Support either point-to-multipoint as traditional TR-069 does, but also provide multipoint-to-point with concrete policies to manage public and private channels channels.

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- o Decentralization of operations by allowing adhoc managers to temporarily interact with one or more devices. For example, troubleshooting sessions.
- o Share information with other management systems and applications using the enterprise bus.

Figure 5 shows the current TR-069 model. The ACS acts as a broker for the managed devices. The interactions from a separate entity (other NMSs, Management consoles) use proprietary means.
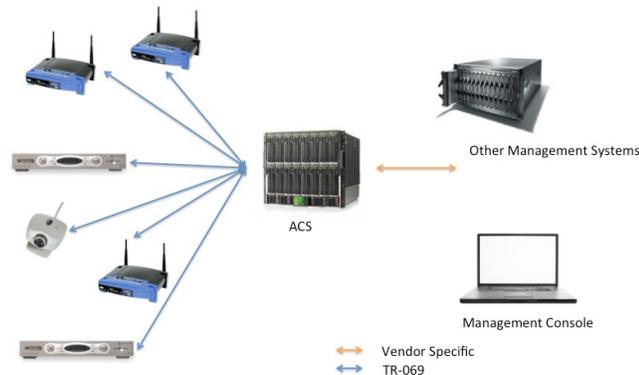

Figure 5 TR-069 Management Model

Figure 6 shows the separation of management and control functions of the ACS of the proposed model. The Device Registration (i.e., Inform, Connection Request), and device management (request/response messaging) via websockets. The architecture is further enhanced by decoupling the logic and state machine of the ACS into a distributed system by using an enterprise bus. There are many available solutions that connect websockets to enterprise buses.
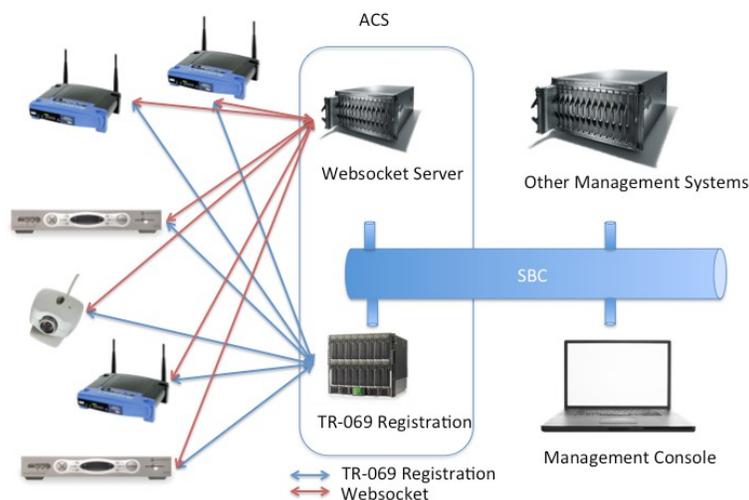

Figure 6 Proposed TR-069 Protocol Infrastructure

Management entities domains.

The lightweight aspects of this invention expand the TR-069 capabilities beyond network devices and target the management of mobile devices and even applications and Web

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applications. Application frameworks such as iOS, Android, Linux packaging, OSGi and others can be brought to the management plane. This allow targeting the following managed clients

o   Network, appliances and mobile devices.
o   Standalone applications using a common management API at the OS level or each application embedding the proper management stack.
o   Web applications (ephemeral sessions). The web application loads the management client entity and information context (instead of the TR-069 notification schema) during the web page download.
o   In the security side, web applications will be restricted to same to same origin policy as any web browser for the WebSocket creation. But this restriction does not apply to all other models

b.   Why was the invention developed? What problem(s) does the invention solve? How is it better?

TR-069 is well positioned in the telecommunication industry for CPE management. However, its implementation is not trivial. A new set of devices (E-Health, Electrical Grid) could take advantage of the TR-069 infrastructure if the communication protocols are light and simpler.

c.   Briefly outline the potential commercial value and customers of the invention.

Currently millions of devices support TR-069. This invention can provide a faster path for fast implementation and broader adoption for the benefit of Service Providers and users alike.

4.   HOW is this invention different from existing products, processes, systems?

This invention disclosure is intended to extend the TR-069 protocol and documents the IPR aspects of this invention and how to integrate into the current protocol.