

# Quickly interoperable Internet of Things using simple transparent gateways

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**Abstract**—Daily experience acquired experimenting the emerging protocols for the Internet of Things (IoT) highlighted the importance of a seamless and direct interoperability with the big Internet. Ease in the deployment and integration with well-established technologies is an even more important requirement when pursuing the adoption by the general public.

We advocate the use of general-purpose transparent gateways, a direct evolution of well-known transparent proxies, performing full protocol stack translation between the future IoT and regular Internet protocols. Low-cost smart gateways, easily deployed in current network topologies, are a promising solution to boost IoT smart objects adoption by regular Internet users.

## I. INTRODUCTION

The IETF is currently leading many efforts to design Internet standards suitable for constrained environments, recently looked with increasing interest for their strong relation with the Internet of Things (IoT).

Such activities include three working groups currently active in the different IETF areas: *i*) 6LoWPAN in the Internet area, *ii*) ROLL in the Routing area, and *iii*) CoRE in the Application area.

The growing interest on this topic among different IETF areas is expected to produce soon a new protocol suite enabling the interoperability between the regular Internet and this emerging constrained environment [1], [2], which is envisioned to be composed of a very wide range of smart objects with different communication technologies, such as wireless sensor networks and wired control systems (Homeplug).

## II. SCENARIOS

Future Internet scenarios foresee the simultaneous interoperation between the protocol stacks coexisting in the two different kind of endpoints, the regular host and the constrained one.

Indeed the actual deployment of constrained hosts, and their interworking with the general Internet, imply additional complexity for providing communication from the source up to the final destination: at least the presence of a gateway mapping the two complete protocol stacks is needed between the two environments.

To ease the deployment of such new solutions, for the sake of interoperability, we argue that additional efforts should be put on investigating possible issues jeopardizing a wide adoption of the new protocols in these usually crowded networks.

Possible gateway issues include: *i*) low-scalability on crowded WPANs (e.g. complex load-balancing), *ii*) high-cost of gateway setup, *iii*) needs of different gateway for each application/technology, *iv*) end-to-end security and trust model, and *v*) scalability and transparency issues on TCP/UDP protocols mapping.

In the following section a cross-WG proposal for the resource-constrained networking area will be outlined.

## III. INTERNET OF THINGS TRANSPARENT GATEWAYS

IoT networking challenges are receiving increased interest from different engineering areas of expertise, as the active working groups in the different IETF Areas. The ideal outcome of the various different works would be a constrained protocol suite, suitable for smart objects and directly interoperable with the Internet.

IoT next-generation devices are expected to be deployed soon in residential and industrial environments, thus straightforward interoperability with the already present network will be a paramount requirement. Interconnection with regular Internet devices has to be obtained using simple low-complexity appliances, as could be a low-cost general-purpose plug-and-play IoT transparent gateway.

This smart gateways could be an important tool to boost widespread adoption of IoT technology, if their setup complexity and their cost (e.g. CaPex and Opex) is limited: to this end explicit analysis is required along the design of IoT protocols. Between the well-established HTTP/TCP/IP Internet protocol stack and the new one, strong attention is required to preserve the mapping complexity to the minimum required.

A first concrete example is the interaction at the application level between HTTP and CoAP protocols, a seamless interoperation between them is an important requirement and discussion on this is still required [3]. Even if simpler, 6LoWPAN deployment procedure and its interaction with already present IP networks should be deeply analyzed, especially the interoperation with network environments still lacking IPv6 support, where, at least in the near future, will be required a seamless integration with IPv4 connectivity. Further evaluation may also be useful to investigate possible NAT-related issues.

More work in the IoT area will be probably seen in the future, to develop technologies fitting better this particular networking environment. As an example, an ideal future addition would be a transport protocol suitable for the IoT

and directly mappable to TCP (if feasible), so that a regular TCP connection can transparently flow into the constrained network and access the available services, by passing through a low-cost general-purpose IoT gateway mapping TCP to a lightweight transport protocol providing reliability.

The most important feature of this constrained transport protocol will be the capability *i*) to be transparently mappable to TCP, and *ii*) to obtain an efficient throughput in a multi-hop WPAN.

Moreover, from our experience, currently to benefit from local WPAN multicast a constrained network gateway is required to offer a service to access the local multicasting features at the application-level; given the high prominence of multicast in an IoT environment to prevent congestion [4] due to multiple requests and thus limit also the energy consumption of this devices. For this reasons the investigation of solutions to get end-to-end or smoother multicast adoption are also encouraged.

#### IV. IS AN “INTERNET OF THINGS” WG NEEDED?

A cross-WG evaluation effort is probably needed to proactively bring forward possible issues preventing the realization of such gateways. A possible solution to this might be to create an IETF General Area or IRTF “Internet of Things” working group, chartered to harmonize the outcome of parallel activities and to solicit discussions about interaction with popular standards.

The ideal outcome of such WG would be to observe the progress of such technologies, promptly evaluate possible interoperation issues and sketch the roadmap to get to a future Internet where constrained devices are smoothly plugged to the network. To this end the development of plug-and-play general-purpose IoT gateways will minimize the setup cost and should provide the desired level of scalability for each specific network.

Moreover, an increase in the mutual cooperation among WGs is recommended to avoid possible inconsistencies in the resulting integrated protocol suite, and especially in the interoperation with widely accepted technologies such as HTTP.

IoT technologies can largely benefit of having a higher interoperation between the parallel IETF WGs active in the field. Moreover a stricter collaboration with well-known experts from active WGs of related Internet protocols is very useful, e.g. soliciting discussion between people involved in httpbis and CoRE WGs.

During the design of IoT protocols, in order to realize a coherent IoT vision, regular collaboration between the involved WGs should be encouraged, in order to keep the alignment on the common goals of integration and interoperation of both the protocol suites. The useful harmonization and interoperation activities can be regulated by this WG.

To this end the “Internet of Things” WG should solicit discussion on the long-term objectives, harmonize the working groups efforts and proactively define a smoother roadmap targeted to the realization of IoT objectives in the most efficient and interoperable way.

#### V. CONCLUSIONS

A complete protocol stack for the IoT should be designed to guarantee seamless integration with well-established standards, and general-purpose transparent mapping gateways can be the tool to demonstrate its feasibility, thus becoming a new-generation of IoT access points, even supporting other standards (e.g. WiFi, LTE, etc.).

In order to realize this long-term vision specific efforts are needed to promptly evaluate issues preventing this realization, harmonization and evaluation of the whole IoT protocol stack can be tasked to an “Internet of Things” WG.

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