



UPnP: The Discovery & Service Layer For The Internet of Things

April 2015

The First Chapter: The Connected Home

In late 1999, the founding members of what would become the UPnP Forum started to put together their original framework and specification to connect the growing number of connected devices in the home.

At the time, the primary use case was broadband sharing. Multi-PC households were just beginning to take hold, fueled by lower priced computers and newer networking technologies such as Wi-Fi. Over the next few years, tens of millions of consumers would begin sharing high-speed Internet. In a few more years, the same consumers would be gaming online, listening to streaming music services and watching Netflix and YouTube on their TVs.

The success of the UPnP Forum's early work exceeded all expectations. Over the next decade, UPnP technology helped fuel an explosion in home networking and connected entertainment as over a thousand companies would eventually become members and over 2 billion UPnP enabled products would make their way into consumer's homes.

The Internet of Things Opportunity

As the rise of consumer connectivity envisioned by UPnP Forum became a widely adopted reality, a whole new set of driving forces began to reshape the technology landscape over the next few years. The arrival of mobile computing, cloud and big data, alongside massive advances in embedded computing and sensor networks combined to create the foundation of the next wave in technology evolution in the Internet of Things.

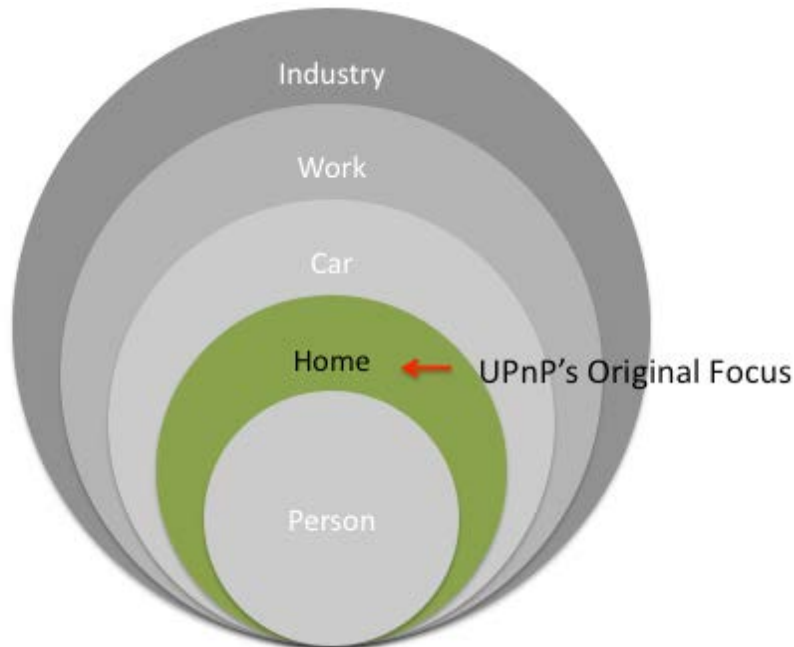
The expectations for the Internet of Things are impressive. According to Cisco, the Internet of "Everything" is a \$19 trillion opportunity, while companies like GE see markets like healthcare garnering an extra \$63 billion in incremental value over the next 15 years.

While the arrival of the Internet of Things has created significant excitement across the technology, investor and media communities, it has also sparked conversation about the necessity for industry and technology interoperability. The promise of the Internet of Things is only possible when proper device and service discovery frameworks are in place, the foundation of which provides a way to bridge device, network, company and industry divides.

A New UPnP For The Internet of Things Era

This need for enabling software frameworks to power the Internet of Things has created a new opportunity for UPnP Forum to expand beyond its original focus.

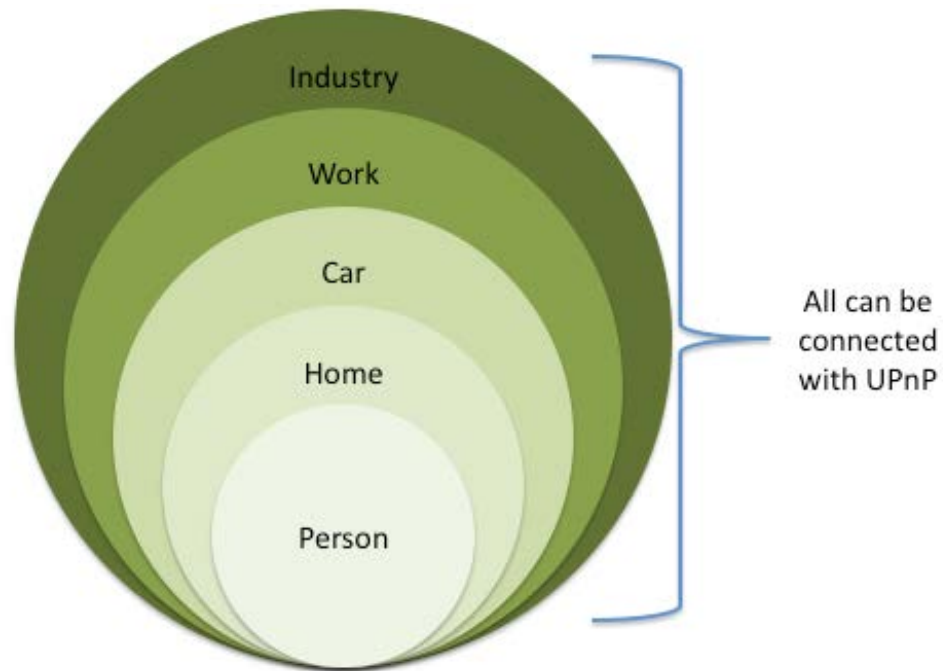
Figure 1: UPnP Forum's Original Focus



The above graphic illustrates the focus of the original UPnP standard. The connected home, which has seen significant adoption and change over the years as consumers have embraced connected entertainment devices, was at the center of UPnP Forum's first wave of success. While UPnP technology was ahead of others with discovery frameworks for devices such as automatic blinds, HVAC and lighting (first certification 7 years ago, other segments of the Internet of Things such as industrial technology and M2M matured largely independent of UPnP and remain largely siloed in the past.

However, industry and technology silos are unsustainable if the Internet of Things is to reach its massive potential. By definition, the Internet of Things requires a dissolving of artificial barriers between markets, where every "thing" with an embedded sensor and computing intelligence becomes part of a much larger world where things are connected, have access to services, and share data with one another.

Figure 2: Addressable Markets for UPnP in IoT Era



This is where an established framework like UPnP can help. By increasing its scope beyond the connected home (as seen above), UPnP can provide the necessary discovery and service layer for the Internet of Things and enable device, network and service interoperability. The above illustration shows what segments of the Internet of Things that could benefit from UPnP.

UPnP+: A Modern UPnP For the Internet of Things Era

When the Internet of Things was on the horizon, UPnP Forum realized it had a significant opportunity to meet a growing need in the market for a mature and future-proofed connectivity framework. It began to prepare the specification for the future, and the first step in this process was identifying the requirements of a modern and adaptable standard.

Below are requirements of a modern connectivity framework for the Internet of Things:

- **Must Be Built For a Modern Internet And Be Backwards Compatible:** Any modern connectivity framework needs to integrate the latest Internet technologies, including IPV6, while also being backwards compatible with IPV4.
- **Must Be Cloud Compatible:** Devices in the Internet of Things require seamless connectivity to the cloud, including web services, software and content.
- **Must Be Interoperable Across PAN, LAN and WAN:** Needs to work across a variety of networks and protocols, with both IP and non-IP networks, including low-power devices on networks such as Z-Wave, Zigbee and Bluetooth.
- **Must Be Secure:** The Internet of Things opens up potential new vulnerabilities. Any standard must have robust security built into the core specification.
- **Must Be Scalable:** With forecasts for the Internet of Things reaching tens of billions of devices, foundational platforms must be scalable.

With these requirements in mind, UPnP Forum built the next generation of UPnP with UPnP+. UPnP+ is a modern standard built for the future that also leverages the core competencies of a standard with over a decade and a half of market acceptance. UPnP technology is already installed on over 2 billion devices the market, already has established device control protocols for automation of devices such as HVAC, security and lighting, and a robust security framework that is now a required part of UPnP+® Certified products.

On top of this solid foundation, UPnP+ adds the following key components:

Bridging and Sensor Management. UPnP+ is written to support a variety of sensors and actuators across a variety of radio technologies such as Wi-Fi, Z-Wave,

Zigbee, Bluetooth and more. The UPnP+ architecture allows for low-power bridging of IP and non-IP devices.

Additionally, the UPnP core standard has already laid a foundation for the IoT hub – a necessary component in bridging the different IoT networks - in with its UPnP Internet Device Gateway (IGD) standard, a software framework that today is installed on tens of millions of routers already in the market.

Cloud And Anywhere Access Built Into Standard. UPnP+ makes cloud connectivity a core part of its architecture by mapping UPnP devices to the cloud using the mature and well-recognized XMPP framework. XMPP also UPnP+ to virtually any web technology and enables devices anywhere to communicate with any other device using this same proven protocol that enables private and secure communication in today's Internet chat rooms.

Robust And Scalable Data Model Built for the Internet of Things. The UPnP data model has been updated for the Internet of Things to account for sensor access, management and data. The UPnP+ data model enables a new IoT device to be defined within minutes without the need for a new specification, allowing those building products and services with UPnP to scale at the speed of the Internet.

Security: UPnP+ certification requires implementation of the DeviceProtection:1 security service, a new service developed in 2011 to update the original UPnP security standard from 2003 to address new threats and an evolving consumer device landscape. Easier to set up and modernized to recognize the prevalence of technologies like Wi-Fi, the new DeviceProtection:1 service is a role-based security model that is expected to be baseline protection to billions of new IoT devices.

UPnP+ And The Internet of Things Industry

While UPnP Forum has worked hard to create a modern specification to help the Internet of Things to reach its full potential in UPnP+, they recognize they are not the only group working to develop a standard in this exciting and highly dynamic market.

In addition to working closely with all of the physical layer technology standard bodies overseeing such standards as Zigbee and Wi-Fi, the UPnP Forum is actively open to alliance agreement opportunities with others developing connectivity frameworks. The UPnP Forum's decade and a half of experience developing a robust standard for device discovery and control in the connected home is unparalleled, and they look forward to working with others to help the Internet of Things deliver on its promise.

At the same time, UPnP Forum believes they offer what is the best foundation for the Internet of Things today. A quick comparison of UPnP to others in Figure 3 below shows the advantages of UPnP and UPnP+ relative to emerging frameworks.

Figure 3: IoT Software Framework Comparison Matrix (Source: UPnP Forum)

	UPnP	AllSeen	OIC	HomeKit	Works with Nest
Open-Source	Yes	Yes	Yes	No	No
# of Devices in Field	Over 2 billion	Less than 5 million	New – less than 1 million	None as of March 2015	Less than 10 million
Physical Layer Agnostic	Yes	Yes	Yes	Maybe	Maybe
Years of Development	14	4	1	1	1
Member Companies	1000+	~150	~70	?	?
App Multiplatform?	Yes	Yes	Yes	Control points only iOS	Works with iOS, Android
Specialized silicon required?	No	No	No	Yes	No

UPnP's wide adoption in over 2 billion devices is due in large part to UPnP Forum's embrace of both commercial and open source environments. Today UPnP development tools and code bases are available across every major operating system including Windows, iOS, MacOS, Linux, and Android, is available in a variety of open source projects, and runs in a variety of programming languages such as C, C++, Java, Javascript and Python.

Summary

Today's Internet of Things landscape is one that holds great promise. As this new set of disruptive technologies based on advances in embedded computing, sensors, cloud and big data begins to take hold, most experts believe we will see huge changes across nearly every industry. Massive shifts in business and operational models in medical, manufacturing, consumer goods and other industries are just the beginning, as companies completely reinvent the way they create and offer products and services to consumers.

However, the promise of IoT and the resulting creation of new economic value is entirely dependent on the ability of these new technologies to reach across industry, company and consumer divides through a robust set of agreed upon software and technology standards. Today's lack of a widely agreed upon interoperability and discovery framework threatens to slow adoption of the Internet of Things and, even worse, means that it fails to deliver on its promise.

With UPnP and UPnP+, the industry has a proven, established discovery and control framework built for the Internet of Things. By building upon the foundation laid through the adoption of UPnP technology by over one thousand companies, 2 billion products and nearly fifteen years of experience, UPnP+ has incorporated modern capabilities such as access to cloud and web services, sensor bridging for any device regardless of power profile or network, a flexible and easily expandable data model and a robust security layer to create a future-proofed standard built to enable the Internet of Things to reach its full potential.

UPnP: promoting interconnectivity

UPnP Forum, established in 1999, is an impartial global industry standards body, that has paved the way for seamless connectivity between more than a billion devices. Its 1000+ companies and organizations work together to enable device-to-device interoperability and facilitate easier, better home networking. UPnP promotes adoption of uniform technical device interconnectivity standards and certifies devices conforming to these, paving the way for seamless connectivity between more than a billion home devices running above the IP layer.

The Forum has widened its scope to encompass the Cloud, including integration for content and services, as well as bridging to non-UPnP networks (ZigBee, Z-Wave, Bluetooth, ANT+...). This enables a broad range of applications including health & fitness, energy management and home automation.

Contact: Scott Lofgren - President and Chairman, UPnP Forum
+1 503-619-5223 | upnpadmin@forum.upnp.org