



Enabling Voice in the Smart Home

A Parks Associates Whitepaper Developed for ULE Alliance



Enabling Voice in the Smart Home

Voice control and voice-based technologies have experienced massive growth in the past five years within the consumer market. **At the beginning of 2017, 49% of U.S. broadband households were using a personal assistant through an application or dedicated device.** Due to its accelerated growth and consumer interest, the voice-first landscape is rapidly changing and influencing the adoption of voice-enabled products.

Market leaders such as Amazon, Google, Apple, Microsoft, and more recently Samsung continue to announce new product enhancements and expanded roadmaps:

- **Amazon** has already introduced its second- and third- generation devices with the Echo Tap and Echo Dot, followed by the Echo Look and Echo Show. Most recently, Amazon released a line of new Echo devices — the Echo Plus, Echo Spot, Echo Connect, Echo Buttons, and an update to the original first-generation Echo.
- **Apple** announced its much anticipated smart speaker, HomePod, at its Worldwide Developers Conference.
- **Google** offers its Google Assistant in its flagship smart speaker device, the Google Home. Most recently, it released the Google Home Mini, a smaller and lower-priced form factor, and the Google Home Max, a more premium and more expensive option.
- **Microsoft** has its own personal assistant, Cortana, opting to port in its voice technology in third-party devices such as the Harman Kardon Invoke smart speaker.
- In mid-July 2017, **Samsung** finally rolled out Bixby, allowing users to access the intelligent assistant via a dedicated button on the side of the S8 phone – a button dedicated for calling upon Bixby.

Collectively, companies are competing to stay in the race for dominance in the voice-first market. They are regularly announcing new integrations and partnerships to create innovative voice-based use cases, as stakeholders vie to leverage the current market's momentum to enable a robust user experience.

Creating a Voice-first Experience

The first step companies face in enabling a voice-first experience is to decide whether to partner with a current market offering or to build a proprietary voice solution. Developing a proprietary voice-enabled solution requires a significant amount of resources.

When deciding what underlying technologies and components to incorporate, device makers must answer these questions:

- How much energy consumption will this require?
- How much range will the device need to communicate with other devices?
- How latent will the vocal response from the device be?

The answers to these questions all factor into the user experience.

A number of companies are embedding voice control technology into their devices. There are a variety of product and service categories with distinct core functionalities that benefit from this. These categories cover smartphones, smart home devices, and remote controls and extend to a variety of verticals such as entertainment with smart TVs and gaming consoles, health, and connected cars.

In the smart home specifically, voice will serve as a prime differentiator in the user experience.

The ability to check in on the smart home environment to understand its status and events through a simple Q&A or to control devices hands-free has the potential to further smart home adoption by simplifying the user experience. As consumers embrace and implement voice-based solutions in the home, there will be a need for ubiquitous access to these solutions throughout the home. To enable this, device features such as two-way audio, power efficiency, and portability will rise in importance.

Defining the Voice Market and ULE Intelligent Personal Assistants

An intelligent personal assistant (IPA) or a virtual personal assistant is a software agent that performs tasks or services for an individual through interactions with voice and natural language processing. These tasks or services are based on user input, location awareness, and the ability to access information from online resources.

Examples of voice-controlled personal assistant applications include Apple's Siri, Google Assistant, Microsoft Cortana, and Amazon Alexa.

Smart Speakers with Personal Assistants

Devices like Amazon Echo and Google Home are always-on, Internet-connected speakers with microphones that are powered by intelligent personal assistants. These devices, also referred to as **voice-first devices**, have an interface where the primary input and output are voice, and the intelligent personal assistant is embedded within the device or in the cloud.



Parks Associates classifies **smart speakers with personal assistants** in their own category given the functionalities are a crossover of capabilities from the smart home, connected CE, and audio categories.

Through the convergence of functions across device categories such as streaming music and remote control of other devices, smart speakers with personal assistants have **revolutionized the hardware industry**.

Smart Home Device

A **smart home device** is a single-point device with the intelligence embedded in the device or combined with intelligence provided by software in the cloud. It typically supports cloud-based data and analytics. Popular smart home devices are Internet-connected versions of traditional home products like thermostats, garage door openers, or lighting.



26% of U.S. broadband households own a smart home device.

One-third of U.S. broadband households are familiar with smart home devices.

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ULE

Ultra-Low Energy (ULE) is a wireless technology standard based on DECT and is intended for home automation and IoT. ULE is an extension of DECT, the technology that exists in the cordless phone systems of hundreds of millions of households. VTech, Gigaset, and Panasonic have long been leaders in DECT cordless home phones. The ULE Alliance, which promotes the worldwide adoption of the ULE Technology, was formed in 2013. By mid-2017, the alliance has grown to nearly 120 members worldwide.

Robustness and ease of use are the main challenges for smart home wireless communication technologies. ULE operates on a 1.9GHz frequency band, which is less susceptible to interference; it does not interfere with Wi-Fi or Bluetooth.

Power consumption of processors running algorithms for natural language processing are a significant consideration for manufacturers. ULE technology addresses this issue by providing connected devices with a low-power solution specifically designed for home automation applications.

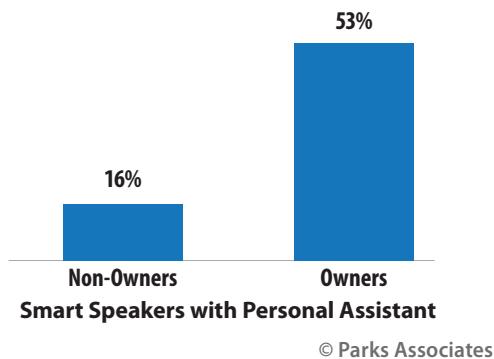
Consumer Adoption and the Voice-first Experience

Parks Associates' latest research shows the average U.S. broadband household has 8.1 connected computing, entertainment, or mobile devices, plus another 2.1 smart home devices. Voice serves as a potential key interface across these devices and also promises to alleviate the complexity in fragmentation. Smart home adoption in particular has been stymied by competing protocols and fragmentation.

An easy-to-use interface such as voice creates a compelling experience for consumers. Once in the home, the voice interface creates a natural gateway to smart home products, with consumers wanting to build their ecosystem around voice, thus leading to greater smart home adoption. Parks Associates' research supports this strong correlation between smart home ownership and adoption of smart speakers with personal assistants.

Overall Smart Home Device Ownership by Ownership of Smart Speaker with Personal Assistant

Among U.S. Broadband Households with/without a Smart Speaker with Personal Assistant



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53% of U.S. broadband households that own a smart speaker with a personal assistant also own a smart home device.

Only 16% do not own a voice-based device but do own a smart home device.

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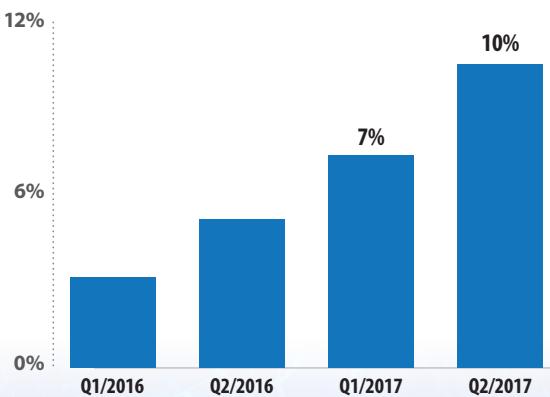
2016 - Sales of smart speakers with personal assistant total 14 million units.

Q1 2017 - 27% of consumers with a smart speaker with a personal assistant report they regularly control their smart home devices with this device.

Q2 2017 - Adoption of smart speakers with personal assistants among U.S. broadband households increases 3% from Q1 to Q2.

As consumers continue to embrace voice technology, the use of voice control in the smart home will become more prominent in delivering on the user experience. These experiences set the foundation for the next phase in the voice race and the expansion of intelligent personal assistant offerings.

Smart Speaker with Intelligent Personal Assistant Ownership U.S. Broadband Households



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Use Cases

The new age in conversational interfaces is shifting the interaction model away from touch, type, and swipe to voice.

This shift is impacting the way consumers are interacting with technology in various market segments. From the smart home to the connected car, voice-based technologies are bringing about the emergence of new use cases.

A key application for voice is in the smart home. Competing protocols and fragmentation have stymied smart home adoption by creating complexity for the end user.

Voice serves as a key interface to alleviate complexity in the user experience.

As devices continue to add listening capabilities, voice control will extend throughout the home as an intrinsic, easy, and natural way to facilitate smart home management. As the consumer experience with voice interfaces improves, users will want this option on a variety of different devices.

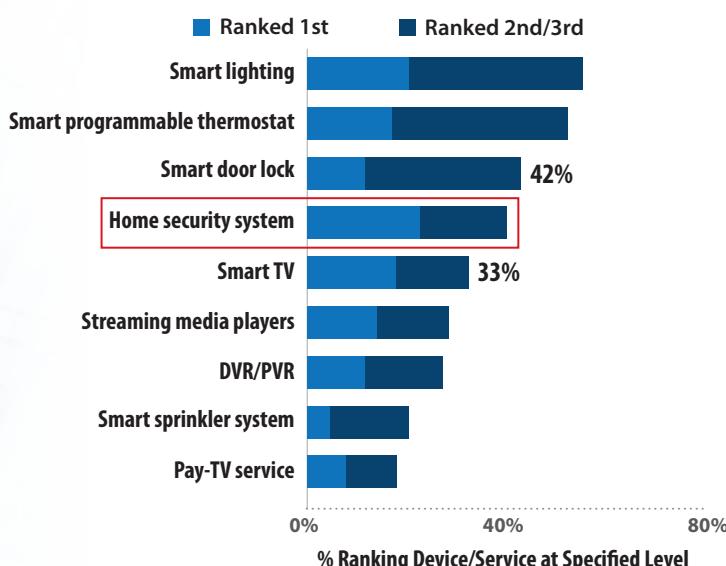
Over one-third of U.S. broadband households find it very appealing to use voice to control smart home devices (37%) or entertainment devices (34%).

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When asked which of their devices they would like to control via a personal assistant, 42% of smart door lock owners and 33% of smart TV owners had these devices in their top three. Among home security owners, 24% ranked this system as the top product they would like to control through a personal assistant, which was the highest percentage among all systems or products to be picked first.

Preferred Smart Home Products for Personal Assistant Control

Device Owners or Service Subscribers Among U.S. Broadband Households



Many smart home devices promote the value proposition of remote control and management, e.g., homeowners can check and adjust their watering schedule through an app that connects to their smart sprinkler system. The majority of consumers see voice as an intuitive way to control these new connected form factors.

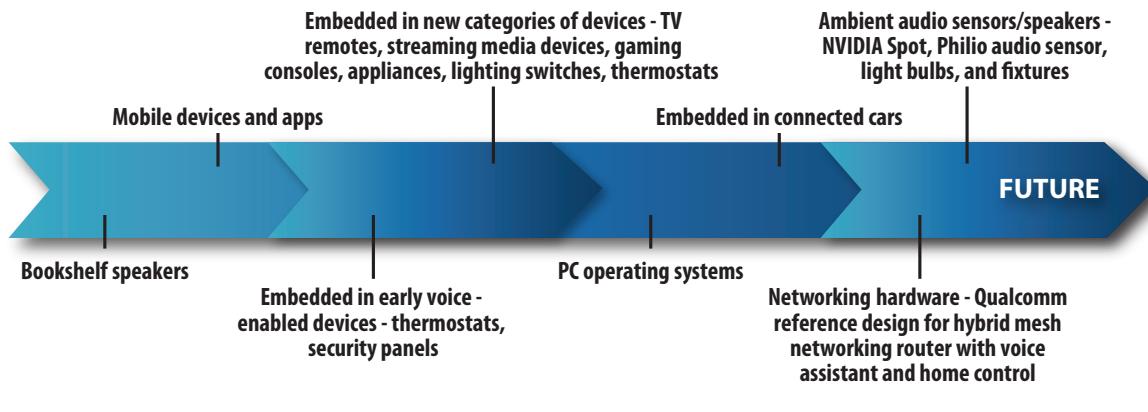
55% of U.S. broadband households find it “appealing” to use voice control to understand the status of connected devices or to control their connected devices.

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Opportunities for Voice in Connected Products

The opportunities for voice integration in connected products are abundant. A growing number of consumer electronics vendors are providing voice services to differentiate and increase the value propositions in their hardware offerings. While consumers are rapidly adopting voice-first devices, the evolution of voice technology will move beyond hardware-centric experiences to ambient sensors throughout the home.

Evolution of Voice Assistant Interfaces



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Examples of Voice Assistants



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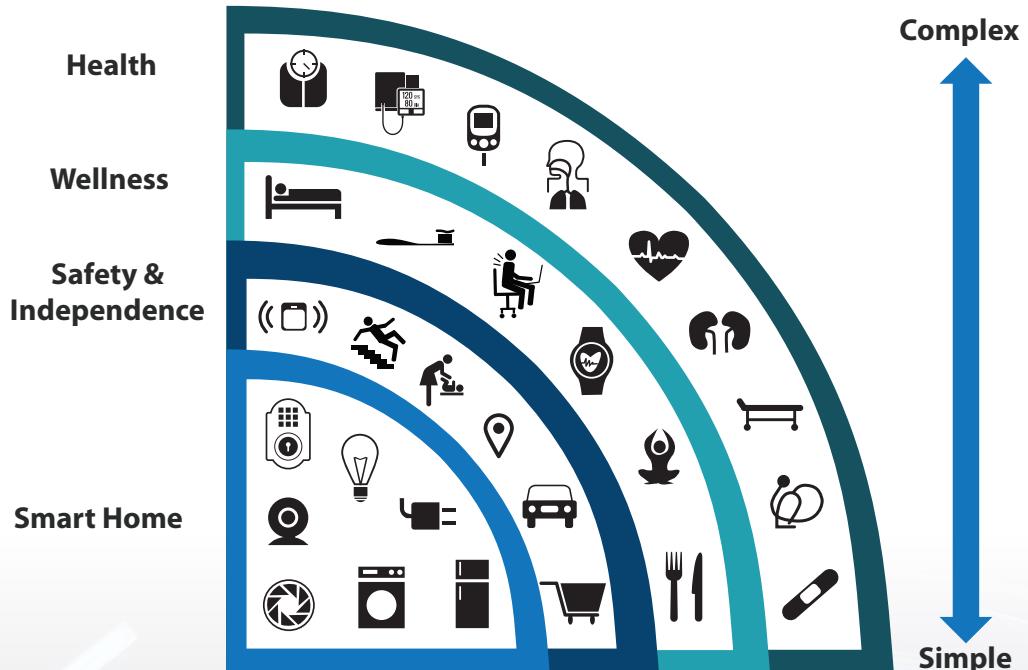
Audio sensors throughout the home allow for consumers to have a voice-first experience without relying on their smartphone or device such as the Amazon Echo.

- Products such as the NVIDIA Spot, a small connected device that can be plugged into any outlet, enable voice throughout any room. Users can walk into a room and provide a vocal command, and the device will execute the request.
- Similarly, the Philio-Tech sensor, which uses DSP Group's ULE SoC (System-on-a-Chip) and audio processors, can provide ubiquity in the home through distributed sensors that can be integrated with popular voice assistants like Alexa and Google Assistant.

Enabling a voice channel in an easy and affordable way will further adoption of such technologies. Products like the Philio-Tech sensor can be embedded into virtually any device to facilitate voice-enabled capabilities. Beyond enabling smart home experiences, this type of technology opens opportunities in providing safety and security use cases.

A sensor can be added to a smoke detector in the home to facilitate central station communication if the siren were to go off. Homeowners can quickly speak to a central station representative to identify and resolve the problem.

Sensors may be embedded in connected health products such as medical alert pendants for the elderly to enable two-way communication during an emergency.



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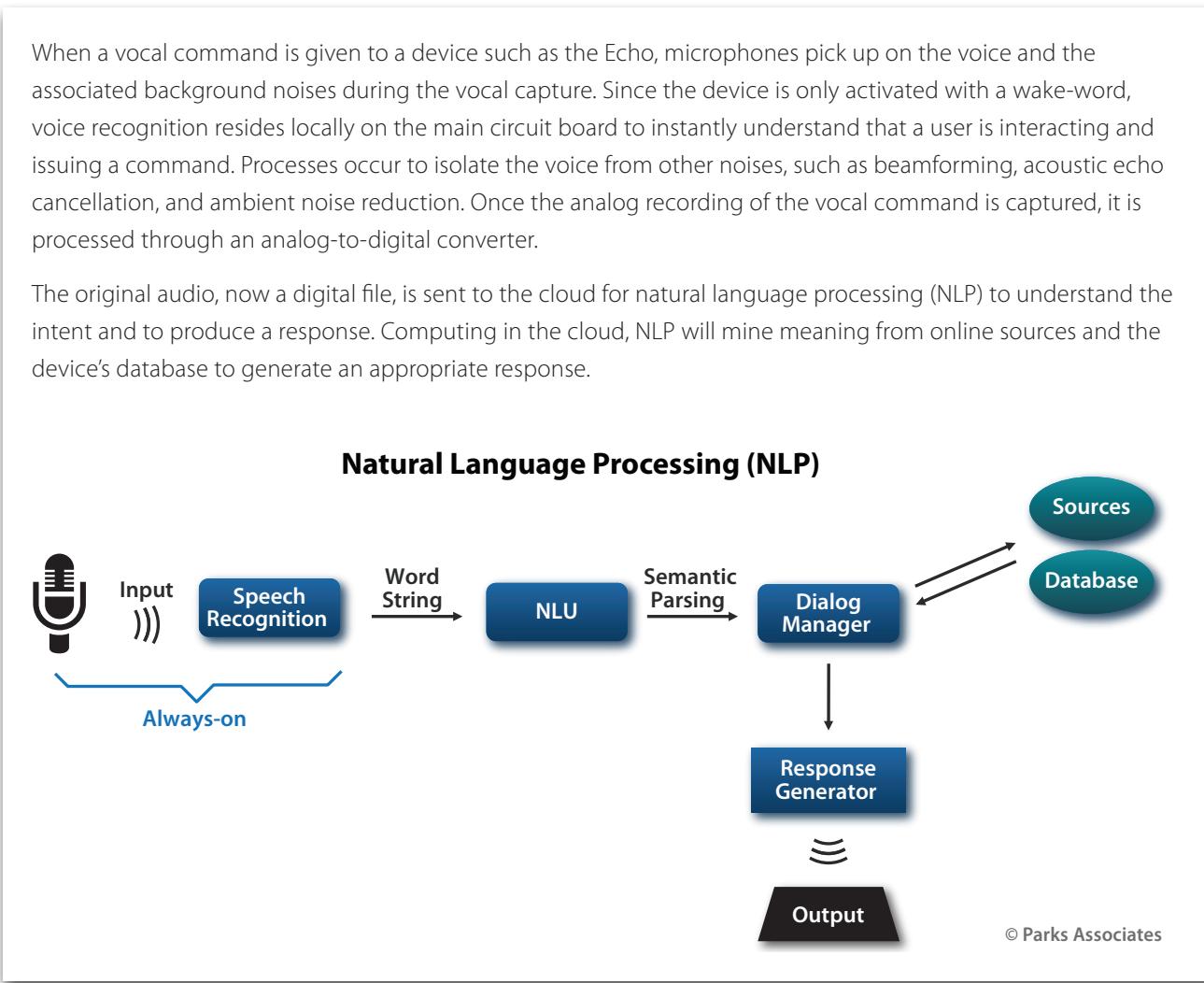
Architecture of Voice Technology

Always-on intelligent assistants that reside within smartphones and voice-first devices can consume a great deal of power. Maximizing battery life on these devices continues to be a challenge for manufacturers. An effective avenue to achieve low power consumption is to focus on efficiencies around components such as the processor, driver, or the chip. In doing so, manufacturers have the opportunity to significantly reduce the amount of power required to enable voice-processing functionalities.

Voice assistant technology relies on two main components: the hardware (a way to communicate and capture commands) and the software (a way to think and to process a response). In order to fulfill these two integral elements, the basic architecture around voice assistant technology requires **a microphone, speaker, voice processor chip, and cloud infrastructure**.

When a vocal command is given to a device such as the Echo, microphones pick up on the voice and the associated background noises during the vocal capture. Since the device is only activated with a wake-word, voice recognition resides locally on the main circuit board to instantly understand that a user is interacting and issuing a command. Processes occur to isolate the voice from other noises, such as beamforming, acoustic echo cancellation, and ambient noise reduction. Once the analog recording of the vocal command is captured, it is processed through an analog-to-digital converter.

The original audio, now a digital file, is sent to the cloud for natural language processing (NLP) to understand the intent and to produce a response. Computing in the cloud, NLP will mine meaning from online sources and the device's database to generate an appropriate response.



Manufacturers are taking into consideration the power consumption of processors running algorithms for natural language processing. Devices that lack a dedicated power source benefit from low-energy solutions. A power-aware design for always-on listening features associated with voice-enabled devices is key for power optimization.

ULE Market Activity



As smart home adoption continues to grow, companies are facilitating ways to incorporate the ULE technology into their product offerings and services. A number of industry players in the market are utilizing ULE to enable smart home solutions.

- Deutsche Telekom, a telecommunications provider based in Germany, has updated its Speedport Smart router to support the DECT ULE cordless standard, in addition to Wi-Fi. Using Magenta SmartHome features, the router has expanded its functionality beyond management of traditional services to the connected home with the ability to control smart home devices.
- Panasonic has used ULE as a standard for its Smart Home system to allow smart home devices such as lights, locks, and cameras, to be connected to the home hub through one push pairing.
- VTech designed a number of home monitoring products based off the ULE standard. Products include connected baby monitors and connected cameras.
- AVM, the largest home gateway manufacturer in Germany, has adopted the ULE standard to its FRITZ! Products. At IFA 2017 in Berlin, it demonstrated its device's compatibility with Deutsche Telecom's products.
- DSP Group and Howdens Joinery, the U.K.'s largest manufacturer and supplier of kitchen appliances, announced a partnership to equip Howdens smart kitchen solutions with ULE technology. This will incorporate Cloud of Things' IoT gateway that features native ULE support.
- Ooma, a U.S.-based VoIP service operator, introduced ULE-based products to enhance its service offering for its customer base.
- The three ULE chipset manufacturers – Dialog Semiconductor, DSP Group, and Intel – offer simple, integrated tools to facilitate ULE-based sensor, actuator, and base product development.

Enabling Voice in the Smart Home

ULE Competitive Positioning



A multitude of control communication technologies – some based on open standards and some proprietary – are used in the smart home. When evaluating the competitive strengths and weaknesses of the different network protocols, the eventual winners will be determined by market momentum, business considerations of manufacturers and service providers, and the technical strengths of the network protocol.

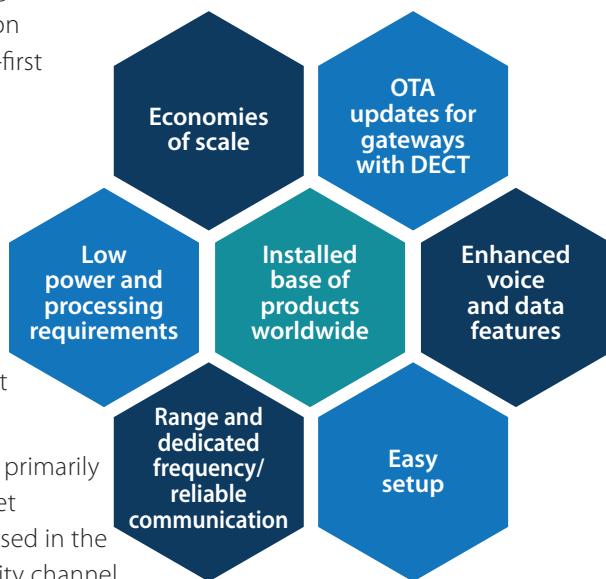
ULE is competitively positioned in the market with the following benefits:

- **Economies of scale** – Over three billion DECT chips have been shipped since the introduction of DECT. Two hundred and fifty million DECT chips are sold annually, creating economies of scale for manufacturers.
- **Installed base** – Since the installed base of gateways and voice-over-IP boxes exceeds ~50 million units in Europe, the avoided capital costs are substantial. DECT is already installed in 580 million homes worldwide, which provides a significant installed base of products to leverage for new applications. Overall, the DECT installed base is approximately 800 million products.
- **Dedicated frequency** – ULE operates in the 1.9GHz frequency band range, avoiding interference and providing highly secure communication compared to technologies that utilize the popular and highly congested 2.4GHz frequency, such as Wi-Fi and Bluetooth.
- **Over-the-air updates** – Any existing gateway that already includes DECT CAT-iq can be upgraded remotely with over-the-air updates to include ULE capabilities.
- **Range** – Long-range capabilities of up to 70 meters indoors and over 300 meters outdoors. In feet, ULE's range is up to ~200 feet indoors and up to 1,000 feet outdoors.
- **Low power and processing requirements** – Low power consumption allows for battery-powered devices to operate for longer periods of time. A ULE module for a smoke alarm, for example — which must send a "Stay Alive" message to the central unit every seven minutes — can be operated for about 18 years if fitted with a CR123 battery (1500mAh). Additionally, ULE boasts low latency for sensor applications that require speedy feedback and communication.
- **Star topology** – ULE benefits from a star topology that results in fewer nodes in the system, longer achievable range from an individual device, and greater reliability for maintaining connectivity. These benefits are achieved without the need for a repeater, thus reducing total system cost.
- **Enhanced voice and audio features** – As a native voice solution, ULE provides superior audio support for two-way communication. Device implementations with ULE can take advantage of its video and audio applications running parallel to each other.

ULE provides greater range when compared to some of its counterparts in the market. Its key competitive advantage for enabling voice in the smart home lies in its origination as a voice solution – specifically built for enabling voice-first experiences in the home. Other wireless home network solutions are as follows and are further compared in the subsequent table:

- Zigbee** – A wireless communication standard developed on the IEEE 802.15.4-based specification to address low-cost, low-power needs for M2M and IoT networks. Strengths include application-specific profiles, a good ecosystem of products, and excellent battery life.
- Z-Wave** – A wireless communications protocol used primarily for the smart home and IoT. It benefits from its market momentum in being the predominant technology used in the leading channel for smart home services – the security channel.
- Bluetooth Low Energy (LE)** – Beginning with version 4, Bluetooth has enabled a dual-mode radio that includes both the classic capability and a low-energy solution. The low-energy radio is used for other applications where the duty cycle can be changed to significantly reduce power consumption and extend battery life. One of the major competitive advantages of Bluetooth LE, also referred to as Bluetooth Smart, is its integration into all major operating systems.
- Wi-Fi HaLow** – A long-range low-power Wi-Fi technology, formally IEEE 802.11ah. It operates in the 900 MHz band and offers campus-wide Wi-Fi coverage. HaLow is being positioned as a technology for smart homes, connected cars, industrial applications, and smart cities. It can reach twice the range of traditional Wi-Fi standards and extends device battery life to months or years.

ULE Strengths



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Comparison of Wireless Home Networking Technologies					
	Zigbee	Z-Wave	Bluetooth LE	Wi-Fi HaLow	ULE
Range	70-90 meters/ 200-250 feet	~100 meters/ 328 feet	~100 meters/ 328 feet	~1000 meters/ 3280 feet	~300 meters/ 984 feet
Frequency	2.4 GHz	908 MHz (USA), 868.42 MHz (EU)	2.4 GHz	900 MHz	1.9 GHz
Security	AES-128 encryption	AES-128 encryption	AES-CCM	WPA2	AES-128 encryption
Advantages	Ecosystem of products, battery life, cable operator adoption	Large ecosystem of products, battery life, retail product availability	Ubiquity in home and electronics, volume, open	Ubiquity in home and electronics, brand recognition, volume	Low interference, long range, native voice solution, handset volume, data rates support voice and images
Voice Capable	No	No	Yes	No	Yes

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Driving the Smart Home Forward

The shift to voice interfaces is apparent as voice becomes more usable and ubiquitous. As the ecosystem of voice technologies continues to grow, stakeholders must evaluate their market strategies and plan accordingly for long-term success. **Device makers must cater to the demand for voice capabilities and deliver a robust user experience.** This includes keeping considerations in the mechanisms behind the technology such as highly reliable communication, battery life, range, security, and so forth top of mind.

Always-on voice assistants need a low-power solution due to the energy it consumes to constantly listen for the wake-word.

A key challenge with voice assistants related to power consumption is that the device needs to be continuously listening. This goes head-to-head with functions in some devices that push for optimizing battery life, such as sleep functions on laptops. Implementing a solution with a power-aware design is necessary for voice-enabled technologies.

Low latency is important to delivering a great user experience.

Response time for voice technologies in particular is critical. Latency between a consumer's question and the device's answer has the power to make or break the customer experience – and should be kept to a minimum. Optimal response times of voice assistants will be those that imitate a natural, human-like interaction.

Future directions for both voice and the smart home are intertwined.

Ultimately, voice control is a smart home enabler – and future adoption of smart home products will hinge on their ability to integrate into a connected ecosystem driven by voice as the standard point of interaction. Integrating voice technology with solutions that support central needs such as low-battery consumption and low latency will drive voice in the smart home forward.

The smart home market is still in its early days. As such, home networks are one of the key building blocks that enable today's smart home systems and products. As new protocols and interoperability frameworks enter the market, competing for adoption, original equipment manufacturers (OEMs) and smart home service providers must decide which protocols or alternative technologies will best enable expansion of their product and service capabilities.

To be successful, each product and application will have to be based on the technology best suited for that particular product or application. As voice is one element that is driving the smart home forward, the ability to provide a solution compatible with voice technologies will grow in importance. In the future, voice may become ubiquitous in the home and in the consumers' everyday lives.

Technologies that natively support voice communication will be in an advantageous position to serve this trend in the future.



About ULE Alliance

The ULE Alliance is based in Bern, Switzerland, with promoter members: DECT Forum, DSP Group, Gigaset; Panasonic and Vtech, and contributor member companies: Arcadyan, AVM, Crow, DEKRA, Deutsche Telekom, Dialog Semiconductor, Howdens, Intel, RTX, Sercomm and SGW Global. www.ulealliance.org



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Dina Abdelrazik joined Parks Associates in 2016 as a part of the connected home team. She has participated in numerous smart home projects and has authored reports on voice assistant technologies, smart home strategies, and home security. Dina frequently speaks at industry events and briefs with many industry leaders about company and product developments. She currently studies market trends and consumer behavior, focused on emerging technology products and services.

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