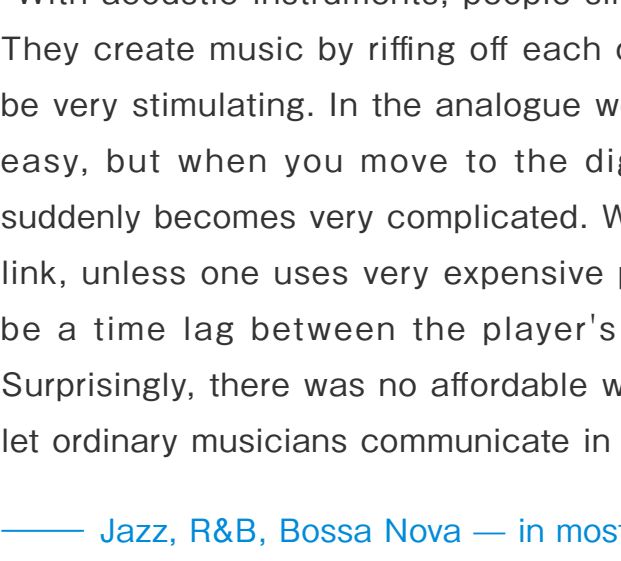


Simply plug a small transmitter into your iPhone or iPod: As if by magic, the speaker system installed in your room is turned on, and music playback begins. Select songs and adjust the volume right there in your palm. No need to move from your seat and go near the stereo system. This kind of smooth operation convenience is made possible by Yamaha's original digital wireless technology "AirWired". A revolutionary idea to free up digital devices from cumbersome connections stood at the beginning. The end result is a system that transmits high-quality music data without delay or degradation.

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01 Bringing freedom to digital instruments



Asahi : "Why is there no wireless technology that allows people playing electronic instruments to easily have a jam session together?" Five years ago, this simple question popped into the mind of engineer Yasuhiko Asahi, at the time working in Yamaha's musical instrument department. With acoustic instruments, people simply can get together and start playing. They create music by riffing off each other, in a give-and-take that often can be very stimulating. In the analogue world, this happens spontaneously and is easy, but when you move to the digital domain, the same kind of thing suddenly becomes very complicated. When sending music data over a wireless link, unless one uses very expensive professional systems, there is bound to be a time lag between the player's action and the arrival of the sound. Surprisingly, there was no affordable wireless technology anywhere that would let ordinary musicians communicate in real time.

— Jazz, R&B, Bossa Nova — in most any genre, the timing is crucial for music to get into a groove. Even with a simple 8-beat, pulling the accent just a tad forward or back can change the whole nuance of a song. When one wants to retain the thrill of the music, data delays in communication are simply not acceptable.

Asahi : "We gave Bluetooth a try, but it turned out to be hopeless. Take for example a guitar. If you strum a chord and then hear the actual clang a beat later, jamming becomes an exercise in frustration. It just won't work. We looked all over for existing solutions, but finally arrived at the conclusion that the only way to go about this was to build something by ourselves. That was the beginning of the long road that led to AirWired."

— Mr Asahi, who became the "idea guy" of the project, actually has quite a reputation within Yamaha as an engineer with a flair for coming up with radically new concepts. In 2002, he created the EZ-EG guitar that has lighted switches instead of strings at the neck, allowing even beginners without knowledge of chords to play music. He also was involved in the development of the TENORI-ON, a unique electronic instrument with a 16 x 16 LED button matrix for playing light and sound simultaneously. An underlying theme here is how to free the music from the small number of skilled players, allowing even persons without special skills to have musical fun.

Asahi : "I care about that probably because I myself am pretty hopeless" laughs Mr Asahi. "When I was in middle school, I sweet-talked my parents into buying me a Yamaha classical guitar. Since then, I've been playing it but still not making any real progress. So I naturally thought that it would be nice to have an instrument that anyone can play. By lowering the bar, as it were, Yamaha creates a kind of cycle that in the long run will have positive repercussions for the company as well. With every project that I worked on, that approach has remained the same."

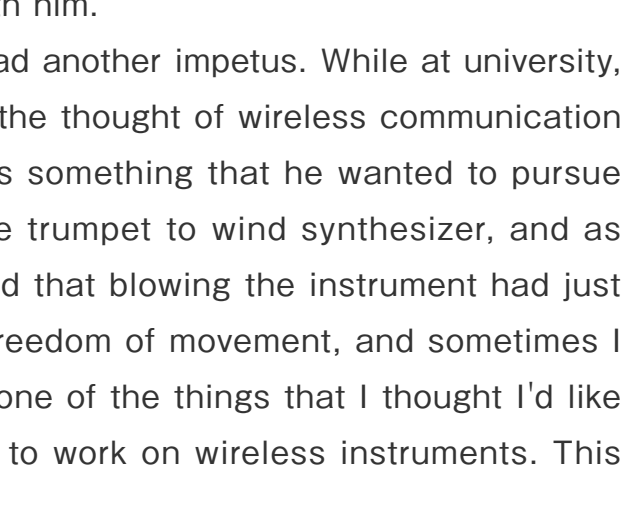
— While struggling with the development of a new wireless communication format, the type of product envisioned by Mr Asahi shifted from musical instrument to portable audio player. 'If we're building a framework for easy session hook-up, why not apply it to something that is even closer to home?' That is the thought that triggered the change in direction.

Asahi : "Just around that time, new mobile phones and audio players with various software innovations began cropping up here and there. So I thought, what if Yamaha were to build a unique kind of portable player that could also be used for impromptu jam sessions. It should have built-in software for guitar, piano, drums, and other applications. While wearing earphones, a wireless session could be initiated for example in a train or anywhere else. To use a somewhat pretentious expression, one could see this as the democratization of music. 'Liberate the digital instruments!' was to be the battle cry..."

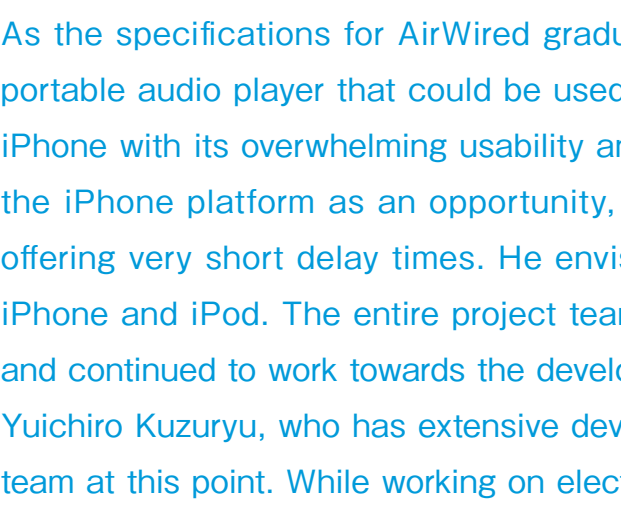
02 The "young warriors" gather round

— In 2007, Yasuhiko Asahi almost single-handedly initiated a project within the company. In an example of lateral cooperation, he was joined by Masato Suzuki from the network department. This young engineer was put in charge of developing the software for AirWired. "To the younger generation of Yamaha employees, Mr Asahi is something of a hero." says Mr Suzuki, glancing fondly at the engineer almost 20 years his senior.

Suzuki : "Even without having met him personally, there are quite a few young developers who were inspired to think outside the box by the encounter with his products. The illuminated guitar is probably the best example. I too had never talked with Mr Asahi until I applied to join the project, but I had always thought that I wanted to work with him."



As for motivation, Masato Suzuki also had another impetus. While at university, he formed a budding Fusion band, and the thought of wireless communication designed specifically for music use was something that he wanted to pursue even then. "I switched from playing the trumpet to wind synthesizer, and as soon as I plugged in the cable, I noticed that blowing the instrument had just become much harder. There was less freedom of movement, and sometimes I ended up tripping the cable. Therefore one of the things that I thought I'd like to do after being hired by Yamaha was to work on wireless instruments. This was a real motivation for me."



— Initially, there were no wireless specialists among the team. Starting basically from zero, the team around Asahi gradually acquainted itself with the field and proceeded to try out the various possible methods and systems. This included visiting trade fairs for wireless technology, conducting

interviews and fact-finding missions, and constructing a series of prototypes. The dominant view at the time held that "wireless audio means Bluetooth", but the Yamaha team had other ideas and applied more stringent requirements. Real-time communication good enough for music use was the goal that informed their efforts. As the specifications for AirWired gradually took shape, an important event in the industry caused the original concept for a portable audio player that could be used for jam sessions to be temporarily shelved. That event was the introduction of Apple's iPhone with its overwhelming usability and great mass appeal. But of course, Mr Asahi did not give up so easily. Rather, he saw the iPhone platform as an opportunity, since it might be able to make optimum use of the sophisticated AirWired approach offering very short delay times. He envisioned a new kind of product, namely a desktop audio system specially geared to the iPhone and iPod. The entire project team was switched from the musical instrument department to the AV equipment division, and continued to work towards the development of this new goal while benefiting from their previous efforts.

Yuichiro Kuzuryu, who has extensive development experience ranging from wireless modules to audio circuitry design, joined the team at this point. While working on electrical aspects of AV receivers, he kept dreaming of a novel kind of breakthrough.

Kuzuryu : "The field of audio development in a way is a craftsman's domain. This includes AV receivers, where requiring improvements for users who are dead serious about sound quality requires a kind of earnest, down-to-earth dedication. Into this environment came Mr Asahi with his ideas to "liberate the music". Quite a different culture, I'd say. Initially, there was a bit of conflict too, but what emerged was something very interesting, I thought. That's why I raised my hand and shouted 'me, me!' when there was an opportunity to join the development team."

— After the team of ambitious young developers had been formed, the cycle of trial and error started again. While retaining the advantages of AirWired, usability as an iPhone/iPod peripheral now had to be realized as well. A full year was spent on development, until Yamaha finally released the Portable Player Dock PDX-50 to the world in the autumn of 2008.

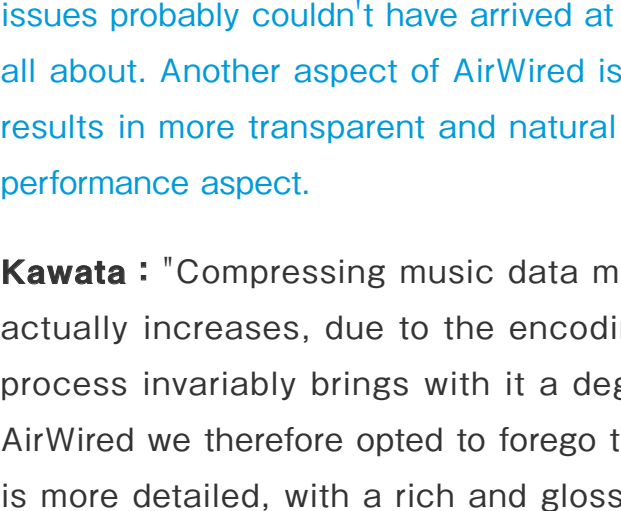
03 The secret behind good sound and minimal delay

— Let's take a closer look at the AirWired technology that is implemented in the PDX-50. The most striking attribute is the absence of any noticeable delay in sound transmission. When using Bluetooth which is the most widely adopted method for wireless audio communication, a delay of about 0.1 to 0.2 seconds, depending on conditions, is inevitable. By contrast, the delay with AirWired amounts to a mere 12 milliseconds (0.012 sec). To illustrate the significance of this difference, it helps to imagine it as a distance. The speed of sound is about 340 meters per second. This means that if a person is standing 340 meters away, the sound of their voice will take one second to reach you. With Bluetooth, the delay is equivalent to talking with a person standing 34 to 68 meters away. With AirWired on the other hand, the distance has been reduced to a mere four meters. As Mr Asahi puts it, this is about the distance between musicians playing a jam session in a small live venue.

Asahi : "A time shift of 12 milliseconds is what only a top-rank drummer would perceive, and that only barely. In a normal hearing situation, such a delay will cause practically no sense of discomfort or lag. When playing a game on the iPhone for example, it is about the same as the interval between touching an element on the screen and hearing the corresponding sound."

— Even when viewing video material on the iPhone or iPod with this system, there is no lip sync problem. Normally, the maximum sound delay considered acceptable for video viewing is about 40 milliseconds (0.04 sec). Unlike with Bluetooth or Wi-Fi, the viewer will not experience any stress in this regard, being able to enjoy dynamic, perfectly matched sound via a wireless link. This is a significant advantage.

So, how was this minimization of delay achieved in AirWired? Engineer Akihiro Kawata, in charge of wireless design, explains that it had to do with getting back to the essentials, approaching the problem from a fresh angle, and having clearly defined goals. This seasoned wireless professional who was head-hunted from another company joined the team after the PDX-50 was released. The aim at the time was to further improve AirWired performance and broaden its range of applications.



Kawata : "With Bluetooth and Wi-Fi, the system has to wait for a response from the receiving side, confirming that data have been completely received, before transmitting the next chunk. It is like the recipient of a postal parcel having to sign and send the receipt back before being able to get another parcel. To maintain communication quality, even a small error will result in a request for resending the data. This of course requires a lot of processing power and results in delays. By contrast, AirWired is tolerant of a certain level of error and keeps sending data. Delays caused by processing are minimized, which can be likened to a farmer delivering fresh produce, even if it has a few dew drops or blemishes still on it. In the sense of applying a "best effort" philosophy, this approach is similar to the principle used for IP phones."

— Instead of aiming for perfection from the start, optimizing the overall balance to convey the music naturally and without effort was the approach at work here. As Mr Kawata points out, a wireless engineer locked in a struggle to solve tricky detail issues probably couldn't have arrived at Mr Asahi's vision, who sees the bigger picture and gives priority to what the product is all about. Another aspect of AirWired is the fact that music data are handled in non-compressed PCM format. This obviously results in more transparent and natural sound quality, but it is also related to the approach of giving priority to the real-time performance aspect.

Kawata : "Compressing music data might be thought to reduce the volume of traffic, but the arithmetic processing load actually increases, due to the encoding and decoding stages. And what's more, the data interpolation required by this process invariably brings with it a degradation of sound quality. So there is almost no advantage to this approach. For AirWired we therefore opted to forego the compression step. As a result, when compared to Bluetooth and Wi-Fi, the sound is more detailed, with a rich and glossy high end and complex ambience coming across beautifully. The determination to focus on the music has really paid off, I believe."

— Within the department, there were initially voices in favour of going with Bluetooth because of its high degree of acceptance. But when AirWired was demonstrated during repeated in-house tests to achieve perfect video/audio syncing with games and movie sources, the doubters were gradually won over. AirWired does not represent a departure from the Yamaha tradition of striving for sonic excellence. Rather, it is a challenge that adds a new dimension to the Yamaha concept of values.

04 Seamless musical experience

— While working towards improving the wireless link performance, engineers Kuzuryu and Suzuki also were brainstorming for various ideas about how to make the PDX-50 more convenient and easy to use. An important point was to free the user from having to think about the speaker system at all.

Suzuki : "When coming home, just unplug the earphones from your portable device and plug in a small transmitter instead. The power to the speaker system comes on automatically, and all control steps can be made at the device in your hand. The speaker system may be tucked away somewhere on a shelf, even in a spot that is hard to reach. I myself wanted to have such a kind of product. Of course, I want to be able to do things such as tweeting while listening to music, and when I get a call, I need to be able to quickly switch to it without hassle. So we designed our software to do the things that we as users wanted."

— The fruit of these efforts is an impressively simple design, with only two unobtrusive buttons on the oblong PDX-50 body. (Initially Mr Suzuki was against including even these remove "power and" volume buttons.) But the less the user has to worry about, the more the engineers have to accomplish behind the scenes.

Kuzuryu : "To establish a wireless connection, the transmitter first has to tell the iPhone or iPod 'I am a bona fide accessory approved by Apple', in what is called the peripheral authorization process. Only when this is successful, power will be supplied and communication with the speaker system becomes possible. A problem here is the fact that there are many iPhone and iPod models and versions, which all have slight differences in operation. To ensure that our product would work with every model and version took a lot more effort than we had anticipated."

— As a matter of fact, AirWired is the only proprietary wireless technology currently approved by Apple Corporation. To obtain approval, high-level experimental proof that the wireless communication does not affect phone operation is required. The team members repeatedly went on overseas trips to have the required tests on their product done by various certification bodies.

Kuzuryu : "The spec requirements posted by Apple are extremely demanding. Most manufacturers sooner or later give up at that stage. AirWired continuously monitors the RF signal and adaptively controls the signal strength of the wireless side to allow problem-free coexistence of voice calls and data communication."

— The important thing here is to anticipate a wide range of actual usage scenarios, in order to eliminate various elements that could inconvenience the user. Engineers must use their imagination and expend a lot of effort in areas that are not necessarily very visible. In the end, this is what determines the true value of the product. Enabling song selection and volume adjustment at the device and eliminating cumbersome pairing procedures, these features all were adopted with the standpoint of the user in mind. It is a manifestation of Mr Asahi's unswerving philosophy, and the younger generation of developers has assimilated this way of thinking during their work on the AirWired project.

05 The expanding AirWired universe

— In the autumn of 2010, a successor model to the PDX-50 with further enhanced performance and convenience features was released under the moniker PDX-W61. In addition, AirWired is becoming available in micro component systems, AV receivers, and the Digital Surround Processor YSP series. The world of AirWired is expanding and starting to provide an exciting range of options.

Kawata : "The wireless specifications are the same, but an improved antenna design process and other measures such as internal redesign to maximise the distance to any metal parts have resulted in notably better reception performance. For the future, we are looking to further refine the communication algorithms and to make the system even less susceptible to delays, also in an environment where there is a high level of Wi-Fi activity. We are already working on several tangible ideas."

— The fact that a single transmitter can operate multiple devices is another sales point, and an AV receiver in the home theatre room. Then one might walk throughout the house with the iPhone in one's hand and enjoy seamless music reproduction everywhere. Again than having to go to the equipment and operate it directly, the equipment moves to one's fingertips, as it were. This rather demonstrates the user-oriented point of view espoused by AirWired.

Kuzuryu : "The new phenomenon called AirWired may bring about various interesting changes also in the home theatre world. For example, by wirelessly sending music data from one's iPod to the AV receiver, the receiver's advanced functions such as HiFi DSP and Cinema DSP can be brought into play to enjoy full 5.1 surround sound. Another possibility that is already being realized is to have a single iPod connect simultaneously to a YSP and a subwoofer. Two formerly separate worlds can intersect and give rise to new and interesting forms of enjoyment."

— Software engineer Suzuki also sees AirWired as a platform that should be released to as many developers as possible. He envisions a range of applications that make use of the minimal delay and high sound quality possible with AirWired.



Suzuki : "Developers writing iPhone apps are of course the obvious target, but beyond that, the platform could also be offered as a framework for other smartphones, games, and PC applications. This may result in new ideas and new ways of enjoying its possibilities." — Born out of ideas for real-time jam sessions, AirWired has progressed into the world of audio. Devices that handle digital sound by nature allow for a wide range of applications and usage scenarios. This is an opportunity for Yamaha to further expand its horizons. And Mr Asahi will doubtlessly continue to push the boundaries.



Asahi : "Traditional acoustic instruments, digital instruments based on them, high-quality audio systems. Yamaha pursues musical excellence in all these three areas, which makes us quite unique. AirWired can be seen to have been born at the cross-section of these three areas. Making music more accessible and open to everyone. I think this is what Yamaha is all about."

Developer's PROFILE
Yasuhiko Asahi
Engineering Manager
Desktop Audio Group
Products Development Department
AV products Division
Involved in development of: AV: PDX-30/50, Musical instruments: "Singing Trumpet" EZ-TP, "Singing Illuminated Keyboard" PSR-J20, USB-MIDI Cable UX-16, Digital Piano P-70/140, Portatone PSR Series, Portasound PSS Series, Digital Drums DD Series
Interests: Performing on the "light guitar" (shows, demos, lectures, training)

Developer's PROFILE
Masato Suzuki
Supervisor
Desktop Audio Group
Products Development Department
AV products Division
Involved in development of: PDX-30/50, PDX-50/60 (US), TSX-140, Animation sequencer (software) for portable terminals
Interests: Futsal, wind synthesizer

Developer's PROFILE
Yuichiro Kuzuryu
Supervisor
Desktop Audio Group
Products Development Department
AV products Division
Involved in development of: YID-W10, YSP-4100/5100, MCR-140, TSX-W80, SWK-W10
Interests: Soccer, bass playing, skiing, golf, Writing, video editing

Developer's PROFILE
Akihiro Kawata
Supervisor
Technology Development Group 3
Technology Development Department
AV Products Division
Involved in development of: YIT-W11TX (TSX-W80, YID-W10, transmitter for PDX-61), YID-W10
Interests: Analogue circuit design (with a preference for speed), cooking, technical writing

