Worlds are About to Touch

TransferJet™ Overview Whitepaper

Spring 2009

TransferJet Consortium

INTRODUCTION

Two worlds exist for today's consumer: content creation and content playback. The traditional end user still consumes multimedia content by watching TV, listening to music, and viewing family photos. But many end users spend almost as much time producing content. They produce video, music, and photos using cameras, camcorders, cell phones, and digital video recorders (DVRs) to shoot, snap, and record events whenever and wherever they happen. The reason this has become so popular is simple: it is very easy to create content with modern equipment. But there is a problem. Content is easier to create than to transfer. This limits the potential for playback and sharing and creates a kind of bottleneck between content production and content consumption. For example, end users want to view digital family photos on their big screen TV. It is possible today using cables and menus. But is that the best way? Does the complexity allow people to fully enjoy photos at their convenience? Is every member of the family able to view photos in this way? What about the end user that wants to transfer digital photos to their PC? That is also possible using a memory card or a USB cable. And many people successfully navigate that existing procedure. But is there a better way? Or does this procedure also limit the enjoyment factor? Many other opportunities exist for sharing content between devices. Every device has some advantage. Some, like camcorders and digital cameras, are better at creating content. Others, like TVs and notebook computers, are better at playing back content. Still others, like cell phones, fulfill both roles in a portable platform. Clearly, the ability to share content between devices is necessary to bridge the two worlds thus enhancing the enjoyment and value of individual devices. This white paper presents a solution – TransferJet™ – which solves the content sharing problem in a way that also achieves high performance, low cost, high security, and most importantly, extreme ease of use.

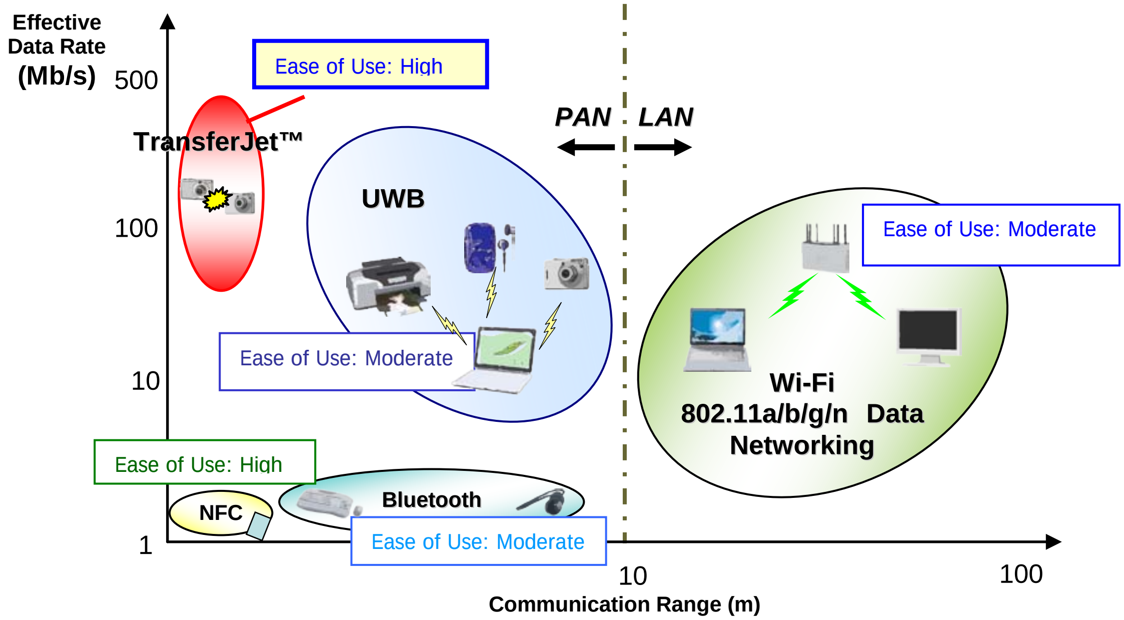

Figure 1：TransferJet™ offers a unique combination: high performance, high ease of use.

TransferJet™ is a new wireless technology that combines the speed of UWB (Ultra-Wide Band) with the ease of NFC (Near Field Communications). By doing so, TransferJet™ delivers a transfer speed of 560 Mbps available to the end user through a simple "touch".

"*TOUCH*" MODEL

How does TransferJet™ achieve all this? The key lies in the "touch" model of user operation. This model requires only a simple touch motion from the user to make things happen. Touch is such a natural motion that people tend to "get it" very quickly. Consider the case of the train network in Japan. Japanese train system adopted touch for the access gates in train stations. The system was so successful that within a year or so it was fully adopted by the general public. It takes only a fraction of a second to pay the train fare by touching a payment IC card to the card reader while walking through the gate. Now it is very common for millions of people to stream through these gates each day, making a touch transaction on every pass. In fact, it is difficult to find riders using the old paper tickets. Similar NFC technology has appeared in payment IC cards, cell phones, taxis, etc. Cell phones often double as train passes. Clearly, touch is a very natural and intuitive motion. That is why TransferJet™ utilizes this same touch motion. Then it extends the performance to also support high speed data transfer.

USE CASES

This powerful combination of touch and speed enables high speed transfer of large data files (photos, video, images, etc) between two electronic products such as mobile phones, digital cameras, camcorders, computers, TVs, game products, and printers. Using this technology in its simplest form, data can be sent at high speed with just a single touch. Other cases involving more complex usage scenarios may require additional user interaction to select the specific data to send as well as the location to store (or method to process) the received data. From a user standpoint, TransferJet™ can be thought of as a universal touch-activated interface which instantly connects a wide variety of consumer (and non-consumer) electronic products. For example, a family can display digital photos on their TV just by touching the camera to the TV or TransferJet™ pad connected to a STB. A tourist can archive digital video simply by placing the camcorder close to the PC. And students can share music with friends merely by touching the cell phone to the music player.

Figure 2: Displaying digital photos on the TV by simply touching the camera

The ease of use enhances these traditional use cases but also creates new possibilities. For example, it is possible to create digital signage and digital kiosks. A person might get files such as coupons, movie trailers, and sound clips by touching TransferJet™ pads placed in public locations. A theme park visitor could download electronic maps and event schedules by touching TransferJet™ pads at the park entrance.

Additional use cases might exploit the contactless nature of TransferJet™ and thus eliminate the risks associated with traditional connector pins that might corrode, bend, or break. Such properties make TransferJet™ ideal in harsh or demanding environments like manufacturing, shipping, clean rooms, or medical.

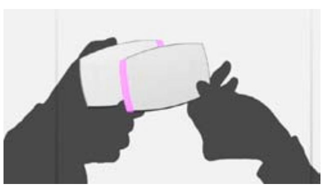

Figure 3: Transferring digital files on the go

Figure 4: Downloading digital contents to a mobile device by touching a digital signage spot

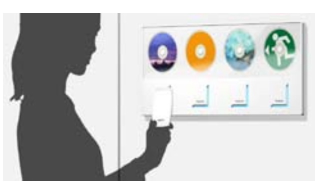

Figure 5: Sampling/downloading music files to a mobile device by touching a music kiosk panel

SPECIFICATIONS

Clearly, the unique qualities of TransferJet™ make it useful for many applications. So let's delve a little deeper into the technical details of those qualities. TransferJet™ can transfer data at a peak speed of 560 Mbps, with an effective throughput up to 375 Mbps. The maximum range of operation is on the order of a few centimeters. And the network topology is always point-to-point. These last two features greatly enhance the simplicity of the system. The short range makes it possible to operate in the near field of the radio signal using very little transmit power – less than -70 dBm/MHz The point-to-point topology greatly simplifies the network setup and management procedures. And since the near field is a non-polarized field, the two devices do not have to be precisely oriented to achieve a good connection. The spectrum is centered at 4.48 GHz, and occupies a bandwidth of 560 MHz. This choice of spectrum, coupled with the extremely low transmit power, enables unlicensed operation in Japan, Europe, the US and other regulatory domains. In addition, TransferJet™ contains a robust protocol which includes error detection and correction, packet acknowledgement, and packet resend. All of these details work together to minimize complexity and interference. The low transmit power and point-to-point topology help to minimize power consumption. Finally, each TransferJet™ device can detect the presence of another device as it comes within range. Therefore, it is possible to save power by transmitting only when another device is detected. This is another advantage of the touch model.

Center Frequency	4.48 GHz
Transmission Power	Below -70 dBm/MHz (average) Corresponds to low-intensity radio wave regulation in Japan, and with local regulations in other countries and regions.
Transmission Rate	560 Mbps (max)/375 Mbps (effective throughput) System can adjust the transmission rate depending on the wireless environment.
Connection Distance	A few centimeters
Topology	1-to1
Antenna Element	Electric induction field coupler

Figure 6: TransferJet™ Specifications

RANGE

At first glance, the short range of a few centimeters might be considered a disadvantage. But when combined with the touch usage model, it actually offers tremendous advantages. We've already mentioned the low power consumption. In addition, the short range virtually eliminates any multipath fading or shadowing present in longer range solutions such as 802.11 or Bluetooth. Thus the connection is very reliable without the need for complex equalizers or advanced signals such as OFDM. This also helps to minimize cost and power consumption. But the biggest advantage is the ability for each TransferJet™ device to discover another TransferJet™ device that comes within range. Since the range is so short, the protocol can reach a key conclusion upon making this discovery: the user has just authorized a connection with the discovered device. Therefore, the protocol can connect the two devices with no further action required from the user. Once this connection is made, the application can take further steps such as transfer a file, query the user, display a file menu, etc. In this sense, the touch motion in the TransferJet™ world is similar to the cable plug-in action in the USB world. One might say that TransferJet™ provides the ease of a USB cable – without the cable. As with every other wireless protocol, devices must proceed through the necessary stages – search, discovery, selection, authentication, connection, and transfer – in order to complete a desired activity. But TransferJet™ is unique because all these steps are collapsed into a single motion: the touch.

COUPLER

Surprisingly, it is not so easy to restrict operation to such a short range. Remember, if two TransferJet devices are not in contact (or near-contact) with each other, they should do nothing - not even detect each other's presence.
That is a very difficult task for a conventional antenna. A typical antenna is designed to radiate a signal as far as possible. To better understand this behavior, consider the field equations shown below for an ideal dipole excited by a sinusoidal current.

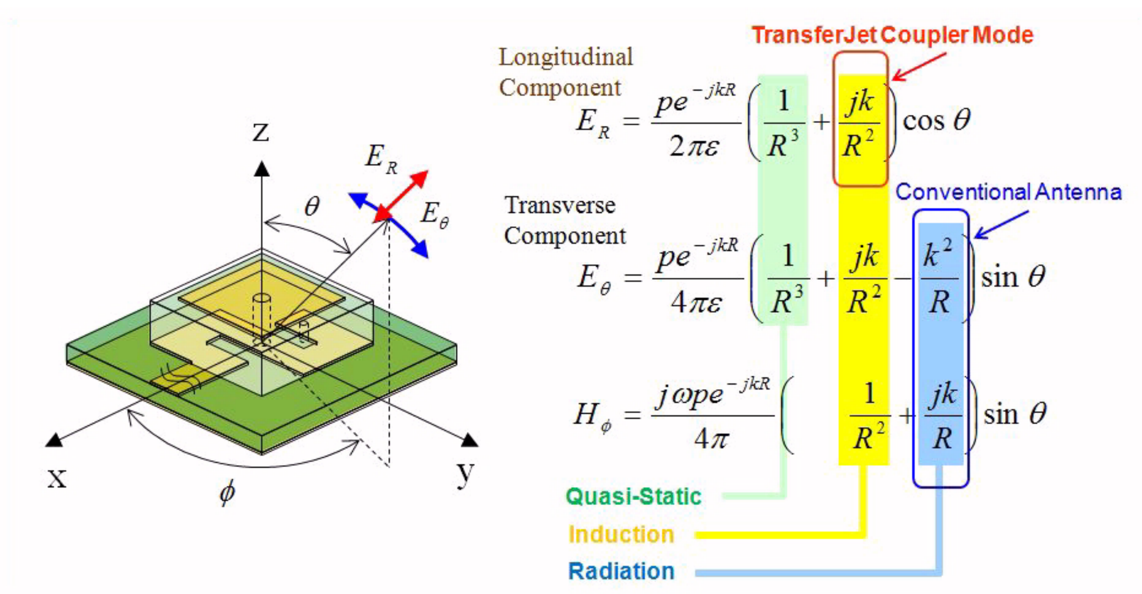

Figure 7: TransferJet™ Coupler design and field equations for an ideal dipole.

The variables in the above equations are as follows:

R = range or distance from the dipole in meters
k = $\omega\sqrt{\mu\varepsilon}$ or angular wave number of a plane wave
p = QL (where Q is the peak charge and L is the length of the dipole)
ω = angular frequency of the sinusoid in radians/sec
ε = permittivity of the propagating medium (air)
μ = permeability of the propagating medium (air)

Notice the field strength of the far-field parts of the signal vary inversely with range. The near field parts, on the other hand, vary inversely with the square of range. Therefore, the near field intensity drops off much faster with range than the far field. The far field also radiates real power. The far field transverse E and H components form the conventional TEM or Transverse Electro-Magnetic wave so common in wireless communications. By contrast, the near field is inductive because it does not radiate real power but instead stores power in the near field. The inductive power is only dissipated if another TransferJet™ coupler appears in the near field. Finally, the near field contains a longitudinal component. This component is important because it is not polarized, making it much easier for the user to align two devices as previously mentioned.

All these factors are combined to produce the unique TransferJet™ coupler. The design of one such coupler is shown in Figure 7 along with the coordinate system from the ideal dipole analysis.

This coupler is not a conventional antenna but instead is designed to suppress the far field component and emphasize the near field signal. The approach creates a virtual bubble of signal energy that drops off very quickly at any range beyond a few centimeters. The result is a usable sensitivity within this distance range. Two typical TransferJet™ devices establish a connection when brought together. But once established, the link will not break unless the devices are separated beyond the bubble distance. This "soft" engage feature further enhances the convenience and ease to the end user.

SECURITY

Although TransferJet™ is a near field, point-to-point technology, it is still a wireless network. So is it secure? This is a very key question. Wireless networks such as 802.11 and Bluetooth have extensive and complex encryption technology built in to the link layer to make sure that an unauthorized receiver cannot access private information. Such link layer encryption is necessary for long range networks because it is impossible to physically restrict access to the network as would be possible with a cabled solution such as Ethernet or USB. For security purposes, TransferJet™ is more like a physical cable. Therefore, it intentionally has no encryption built into the link layer. It would be very difficult for an attacker to gain access to a TransferJet™ connection from some distant location. The attacker would have to be physically a few centimeters away in order to access the connection. If the attacker has to be that close, couldn't they just as easily plug in a USB cable? And remember, everything about TransferJet™ is designed to restrict both the signal level and range of the radiated signal. By eliminating link layer security, TransferJet™ saves power and cost, and further reduces complexity for the user. But it is possible to add encryption at the application layer. Some applications must protect a file's integrity during file transfer regardless of the connection type. TransferJet™ is perfectly compatible with these application-level security measures. Since each device has a unique ID, it is possible to uniquely identify any device that attempts to establish a connection. So TransferJet™ achieves the best of both worlds, the simplicity of touch, with the security of a cable.

PROTOCOL STACK

The TransferJet™ protocol operates under three basic principles:

1) Point-to-point: Connections are always point-to-point. Multi-point topologies are not supported.
2) Symmetry: All devices are capable of initiating or receiving a connection request.
3) Backwards compatibility: The protocol should be as backwards compatible as possible with existing legacy architectures.

To implement these principles, the TransferJet™ protocol defines three layers: The Protocol Conversion Layer (PCL), the Connection Layer (CNL), and the Physical layer (PHY) as shown in the figure.

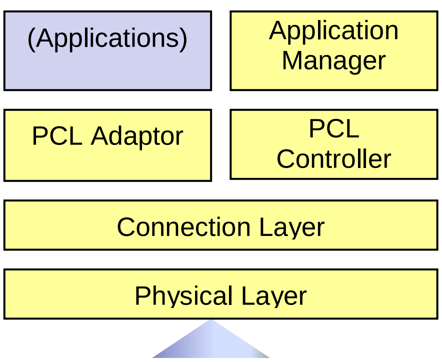

Figure 8: TransferJet™ Stack Architecture

The Physical layer, or PHY, implements the actual radio. This layer converts the digital information into an RF signal suitable for transmission across the TransferJet™ couplers. The Connection Layer, or CNL, manages connections and data delivery. For connection management the CNL is responsible for establishing and releasing the connection to a peer TransferJet™ device. For data delivery, the CNL provides packets to carry the data payload and confirm successful delivery of those packets to the peer device. The Protocol Conversion Layer, or PCL, is responsible for converting from an Application's existing interface standards (such as SCSI or OBEX), and the TransferJet™ native protocol. In this way, for example, a stationary device can access data on a mobile device without modification to the application layer software. There is also a separate Application Management Layer being developed that coordinates and manages the applications, as well as guidelines that define how devices should provide feedback to inform the user of the progress of a transfer operation.

REGULATORY

Since TransferJet™ communicates using a radio signal, it must comply with government regulations in any geographic region in which it operates. In the regions that have clearly established regulations, including Japan, Korea, the EU, and the US, TransferJet™ is compliant for operation indoors or outdoors. The regulatory situation at this writing is shown below.

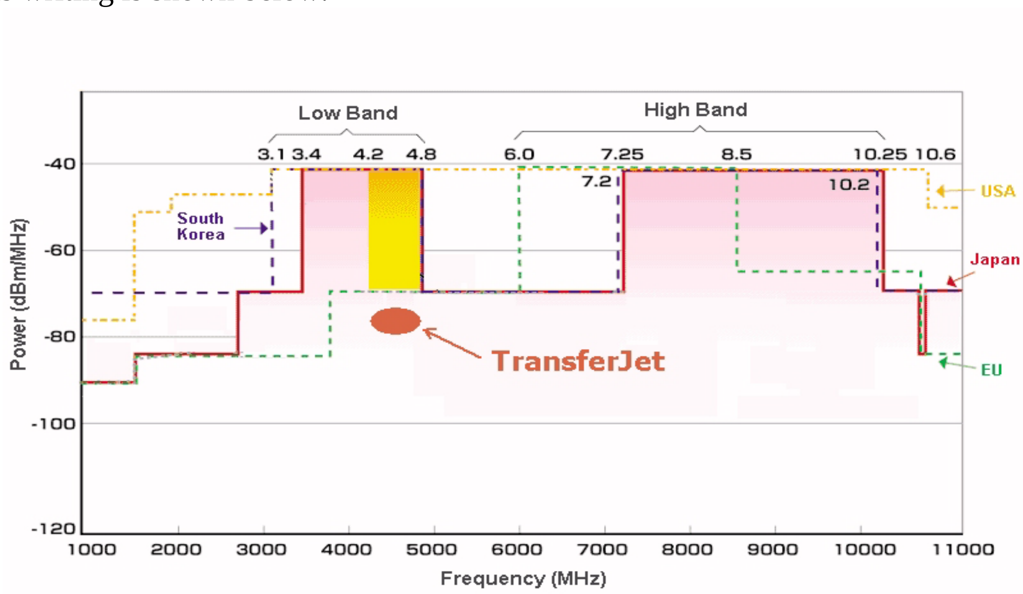

Figure 9: UWB Regulatory Landscape

CONSORTIUM

Clearly, the technology offers significant benefits to the end user. But any data transfer requires two TransferJet™ devices in order to define a use case and complete a transaction. Therefore, multiple products must adopt TransferJet™ in order for it to be successful in the market. That is the purpose of the TransferJet Consortium (www.transferjet.org/en). As of spring 2009, the consortium consists of the following Promoter companies.

- Sony Corporation ("TransferJet Consortium" Administration)
- Canon Inc.
- CASIO COMPUTER CO.,LTD.
- Eastman Kodak Company
- Hitachi Ltd.,
- JVC KENWOOD Holdings, Inc
- KDDI Corporation
- NEC Corporation
- NIKON CORPORATION
- NTT DOCOMO, INC.
- Olympus Imaging Corporation
- Panasonic Corporation

- Pioneer Corporation
- SAMSUNG ELECTRONICS CO., LTD.
- Seiko Epson Corporation
- SHARP CORPORATION
- SOFTBANK MOBILE Corp.
- Sony Ericsson Mobile Communications
- Toshiba Corporation

These companies are currently finalizing specifications to be released as a TransferJet™ open standard. These specifications describe the protocol, the architecture, the use cases, the testing procedures and certification program, and the Trademark guidelines. Preliminary Trademark guidelines are shown as follows.

Figure 10: Preliminary Brand Logo

Figure 11: Preliminary Symbol Logo

Figure 12: Preliminary Target Point Logo

Figure 13: Example of Target Point Logo Placement

It is expected that these specifications will be completed in several installments during the summer and fall of 2009. At that time the consortium will also start accepting Licensees, called "Adopters", who will enjoy access and usage rights to all the completed specifications, logos and other deliverables necessary to develop and market compliant TransferJet™ products.