Smart Shelf™ & The Internet of Things

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NeWave® Sensor Solutions was recently interviewed for the *Discovery Channel's* new web and Facebook program: "Technology is Changing How We Live ". NeWave's Smart Shelf™ was selected by the *Discovery Channel* to showcase future technology in "Cashier Free Retailers" and as an excellent example of a smart device enabling the Internet of Things (IoT).

Why is that important? Let's examine what is the definition of the Internet of Things and the attributes of NeWave's Smart Shelf .

"Internet of things

From Wikipedia, the free encyclopedia

Drawing representing the Internet of things

The **Internet of things** (**IoT**) is the inter-networking of physical devices, vehicles (also referred to as "connected devices" and "smart devices"), buildings, and other items—embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data.[1][2][3] In 2013 the Global Standards Initiative on Internet of Things (IoT-GSI) defined the IoT as "the infrastructure of the information society."[3] The IoT allows objects to be sensed or controlled remotely across existing network infrastructure,[4] creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention.[5][6][7][8][9][10] When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, virtual power plants, smart homes, intelligent transportation and smart cities. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure. Experts estimate that the IoT will consist of almost 50 billion objects by 2020.[11]"

Of course, that estimate for 50 billion objects is referring to devices connected to the internet. In this case, many see the future of the internet as being between machines without human

intervention, which is described as being machine-to-machine (M2M) communication. Obviously, these machines must operate in autonomous mode in that there is no human involved. Besides being M2M, there are many attributes associated with the IoT such as being seamless, scalable, minimal impact on web, provides valuable data and associated analytics, and web installation and maintenance. All of these features have been incorporated into our Smart Shelf solution.

Let us examine each of these attributes in terms of our Smart Shelf solution

To grasp this connection between Smart Shelf and IoT, one has to understand better how our Smart Shelf solution works from start to finish. First, our patented NeWave reader has been specifically designed for Smart Shelf applications in that it is based on an embedded small board computer as opposed to a simple microprocessor used by other RFID readers. This is extremely important in that the Smart Shelf reader must collect all the RFID tag data, process inventory data, compress the inventory data and then transfer data to the customer. Since all these functions require significant software and multiple processes that vary with application running at the same time, it must be done within a computer and not a simple microprocessor. As a result, our reader comes with a complete set of Smart Shelf middleware and network software dramatically reducing solution installation complexity time and cost. In fact, the NeWave reader network software is designed to optimize the system performance and cost by employing the following powerful IoT attributes:

1. **M2M:** Our NeWave reader is uniquely designed for Smart Shelf based on its embedded small board computer. It autonomously sends the compressed product inventory data directly to the customer's server in a form that the customer can directly use within their existing inventory data base. Thus, the customer defines the data format and transfer process making it ideal for their operation. As a result, the user has more timely and accurate shelf inventory data.

2. **Seamless:** It is very difficult to design a system that is virtually seamless in that everything must continuously flow without human interruption from start to finish. For Smart Shelf, one simply connects the NeWave reader to the Smart Shelf hardware and then powers-up the reader. As our reader is powered-up, it automatically connects to our VPN Admin Server. It is able to immediately connect in that we have pre-loaded the proper credentials into each reader. Once NeWave's Admin server receives this initial credential information, it adds this reader system to its operational systems. In return, the Admin server sends a request to the installer to properly define his or her information, location, etc. The installer completes this form and then is informed to install the complete system using a bar code scanner interfaced to the reader. Once the installer completes the installation using the bar code scanner, the reader will automatically process this information and send an initial planogram file to the Admin Server. This initial information includes the product UPC code, product location and associated RFID tray identification number. Once this file is received at the Admin Server, it will take this information and add the product name and dimensions. This will complete the planogram file that is automatically sent back to the reader as well as being stored on the Admin server. When this file comes back to the reader, it will start the normal inventory data collection and the installer will be informed that the installation has been completed. During the normal

operation, the reader automatically checks itself, determines any maintenance issue and sends this information to the Admin server. Once this maintenance information is received at the Admin server, all the reader maintenance is performed over the web unless there is a hardware failure. If it is a reader hardware failure, the reader can be fully corrected by removing the SD card from the old reader and placing it into the new reader. Once this is done, the new reader will fully replace the old one. If the maintenance is associated with the Smart Shelf hardware, it can easily be corrected using the maintenance option with the bar code scanner. Finally, the main objective of Smart Shelf is to eliminate out-of-stock. This is done by the reader automatically sending restock information to store personnel using a local NeWave Wi-Fi network within the store. Thus, the Smart Shelf system is a seamless solution.

3. **Scalable:** Smart Shelf is designed to take advantage of our patented Wave® antennas that have been designed to cover a zone such as a 3' or 4' wide shelving section. The zones can be designed independently as adjacent or non-adjacent sections. The software has been designed so that each reader connects directly to the customer, Admin server and the local store network. Thus, each NeWave reader has software installed and operated in the same form making the software scalable as well.

4. **Minimal Impact on Web:** The IoT becomes effective as more and more systems are attached to the web. This sounds great, but one has be concerned about the impact on the web as these systems are added and sending important inventory data coming from 1000's of our reader systems taking up huge amounts of band width. In our case, the middleware processing within our reader optimally compresses the inventory data and only sends this very limited data on inventory changes a few times per day greatly reducing the amount of band width required. Further, the customer takes this very limited data and integrates it within their existing data bases. Therefore, the customer storage is virtually the same as used previously. The Admin server does not keep any inventory data. It simply stores the store information, shelving planogram and needed maintenance issues. Therefore, it can easily handle a very large number of reader systems. Finally, the store re-stock information is stored in the reader and cleared as each product is re-stocked. Thus, there is very minimal impact on the web even though we may be running 1000's of readers at one time.

5. **Provide Valuable Data:** Our Smart Shelf system provides very valuable information to the customer. For example, the customer can determine the actual product inventory versus time. This can be used to determine very accurately when and what products need to be manufactured in very timely way. Or, it can determine how well their products are re-stocked. Therefore, customers can be using **"just-in-time"** stocking of their products that will result in tremendous savings and a very fast return-on-investment. Finally, forensic analytics can be used on this inventory data to provide a whole set of new information such as season impact, weather impact, local customer habits, the impact of promotions and new products, etc. As historical data base grows the value of the inventory data collected will as well providing greater and greater business insight to the retailer and manufacturer.

6. **Web Installation and Maintenance:** The middleware within the reader automatically knows if the Smart Shelf system has been installed or not. If not as stated earlier, the

installer will simply be notified to start the Smart Shelf installation using the bar code scanner. Once this scanning process is completed, the Smart Shelf planogram is stored in NeWave's Admin server and reader. This is an automatic process done over the internet as explained earlier. The Smart Shelf maintenance is performed by the first using the bar code scanner to interrupt the reader from its normal operation. Once the maintenance person has been informed that the reader is now in maintenance mode, he or she can begin the various maintenance functions by using the bar code scanner as . Note that once the maintenance is complete, the reader will again automatically upload the new potential planogram to the Admin server. The Admin server will again add the product names and dimensions and send this complete planogram file back to the NeWave reader. Note that this complete planogram file will then be stored in the reader and Admin server. Once these steps are complete, the reader will again return to normal inventory data collection.

The NeWave reader comes with our unique middleware and software pre-loaded at no additional cost. The reader and Smart Shelf must be monitored by the NeWave Admin server as described earlier. This becomes a very important function in that the reader will automatically notify the Admin server of any system failure for immediate resolution. Since any failure of the reader short of a hardware failure can be corrected over the web, the customer can be assured that the system is functioning properly 24/7. This IoT benefit will be provided to the customer at a minimal monthly expense per system.

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7. **Sensor Fusion:** The seamless process used for Smart Shelf also takes advantage of sensor fusion in that we are using RFID to collect inventory data but we also use a bar code scanner process to do the installation and maintenance. Using this approach, we are taking advantage of the more valuable attributes of multiple sensors to create the best possible overall Internet of Things solution.

In summary, Smart Shelf has taken full advantage of the IoT attributes to create a unique cost-effective, reliable, accurate and easy to install and maintain shelf inventory solution that eliminates out-of-stock for each individual product placed in our Smart Shelf dispenser trays. NeWave's Smart Shelf is unique in function and performance to prevent Out of Stocks offering a very significant business opportunity for retailers to enter the world of IoT.