The RuBee PAVE Project

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A scalable Patient and Asset Visibility Exchange (PAVE™) based on Visible Technologies (VT) and asset viability networks that has the ability to significantly reduce US healthcare costs and increase safety. PAVE is based on RuBee™ (IEEE 1902.1) a new wireless networking technology that works in harsh environments.

Visibility Technologies (VT) is like Information Technologies (IT) except it converts real world assets into virtual data points, tells you how many you have in stock, where they are located, and if all is OK. VT provides asset location and total asset status, with no change in human process. VT based applications in the procedure and operating rooms have the potential to increase patient throughput by 25% to 30% and reduce direct operating costs by 10% to 15% (1,2). RuBee is a new wireless VT that provides real-time Visibility of assets and people. RuBee provides real-time automated data entry and collection of critical location metrics with no change in human process. A RuBee Visibility Network is unique in that it provides "process free" measurement of patient location, staff location, and mission critical asset status and location throughout a hospital (3,5,7,8,and 9). Many other line-of-sight tracking technologies (e.g. barcodes and RFID) have been used in similar trials over the last decade. However, tracking systems are the same as visibility systems. Tracking systems require major changes in process, complex IT to infer location and status and can only provide line-of-sight identity. That is, participants have to do new things with several rule based manual steps (e.g. using handheld to read a barcode, or an RFID tag). Other non-line-of-sight technologies (WiFi, ZigBee) could potentially provide visibility with reduced process change, but interference issues, short battery life, high tag costs, and large tag size have been major barriers to widespread adoption. The RuBee technology is the only technology that has been commercially successful as a process free wireless visibility of people and assets. RuBee overcomes all technical issues listed above and at an attractive price point (8,9).

The PAVE Project is an orthopedic procedure room clinical trial of a real-time, RuBee Visibility Network. The project has four major goals:

1. Carry out a Phase II FDA trial on a single RuBee (IEEE P1902.1) equipped Orthopedic Procedure Room (OPR) using cGMP standards. Develop and collect Key Performance Indicators (KPIs) on technical systems performance, patient flow data, high valued asset flow, and asset management data (i.e. implants) as well as safety enhancement data. The trial protocol will be based on a minimum of 500 patients over a period of twelve months.

2. Develop methods, systems, and rules for "coaching", supporting, and consulting the hospital staff based on the KPIs developed in the OPR so the patient throughput, disposable asset flow, implantable asset flow and safety are continually maximized.

3. Provide a detailed PAVE net Return on Investment (ROI) in the OPR. The ROI will include all short-term and long-term financial stakeholders.

4. Write an academic, peer reviewed paper published in a well known journal reporting the results “1”, “2”, and “3”. The paper might be considered the pivotal paper on the value of Asset and Patient Visibility Networks within a US based hospital system and its potential ability as a new technology to manage and reduce US healthcare costs.

The RuBee PAVE project is an extension of an initial 5 patient Phase I FDA trial (3,4,5,6,7,8,and 9) and will create a new “process free” visibility infrastructure in a pilot hospital to measure PAVE's ability to increase throughput and reduce healthcare costs in the U.S. Based on preliminary results we expect reductions in the range of 10% (minimum) to as high as 20%.

The project is funded by Visible Assets, Inc., GHX, Oracle and other partners.

Background: Medical Technology and Healthcare Costs

Over the last two decades new medical technology has dramatically improved our expected lifetime, our safety, and in general outcomes within the US healthcare system. However, the same technology has also been responsible for significantly increasing our health care costs (10,11,12,13,and 14). Annual spending on health care increased from $75 billion in 1970 to $2.0 trillion in 2005, and is estimated to reach $4 trillion in 2015 (12,13). Rettig (14) itemizes six mechanisms by which new medical technology increases healthcare costs. Newhouse, in a well known article (13), concludes that the “Rettig factors” account for half (50%) of the growth in real medical spending, with what he calls “the enhanced capabilities of medicine.” created by new medical technology.

Efforts to use Technology to Reduce Healthcare Costs

Many government and private sponsored programs have ongoing programs to reduce costs with new medical information technology (IT). The President’s Health Information Technology Fund of 2004 provided a budget and incentives to enhance the exchange of health-related data and medical records to reduce costs. The 2008 Fifth Annual Survey of Health Information Exchange at the State and Local Levels which included responses from 130 community-based initiatives in 48 states, shows the significant impact fully operational initiatives are having on improving health care delivery and efficiency. "The 2008 survey shows a direct link between the exchange of health information electronically and improved efficiency, reduced costs, and better patient outcomes. These are exciting results and demonstrate that the significant potential impact predicted for

electronic medical records is now being realized all across the nation," said Janet Marchibroda, Chief Executive Officer, eHealth Initiative. However, we believe one additional imporant component in the IT systems must be added and automated to realize a scaleable solution – real-time patient, staff, and asset visibility.

In 2000 Wal-Mart started their well known RFID initiative, and many parallel initiatives were launched around the world in a very wide range of application areas. Many initiatives were undertaken to enhance patient throughput, provide asset tracking within the Operating Room, Emergency Room, and general patient floors. All of these confirmed the potential Return on Investment (ROI) and possibility of substantial cost reductions; however, few were able to produce an economically scalable result for a variety of reasons:

1. **Manual Data Collection**: New patient management IT solutions in large complex organizations can only provide cost reduction with fully automatic data collection. The weakness has been and continues to be that all these new IT efforts depend 100% upon human assisted, manual collection of data.

2. **Manual data entry:** Attempts to automate data entry via Bar Codes has not been successful because Bar code reading requires new manual steps, process change, training, and complex systems.

3. **RFID performance issues around people, steel:** RFID offered the hope that data (patient location, flow, asset inventory, use) could be automated with minimal new systems, new infrastructure and employee training. However, the RFID started by Wal-Mart was dropped by Wal-Mart in 2005 because of read reliability, and because of an inability of RFID to work in harsh environments near liquids and steel. The general conclusion is that RFID in harsh environments is no better than barcodes, requires line of sight reads, and again requires massive process change.

4. **EMI, OSHA concerns:** RFID has many other issues that also contributed to the slowdown in healthcare adoption of wireless asset visibility. A recent article (8) suggests there may be serious Electromagnetic Interference RFID issues with current high wattage systems, as well as OSHA issues with human exposure. Interference with pacemakers and ICD's has also been suggested by FDA.

5. **Limited ROI for Wi-Fi solutions:** WiFi and higher frequency solutions have been tried but so far all have been disappointing because of interference issues, high tag cost, and short battery life. The combination of these factors eliminates the ROI from the effort. As a result, it has been possible to structure pilots where a Wi-Fri solution can be shown to "work", but it has not been possible to scale those pilots into widespread deployments. Most WiFi tag companies have gone bankrupt or are in financial trouble.

The vision and dream of efficient high speed patient throughput in any hospital setting, using modern automated data entry and modern IT systems running like a modern factory, with accurate real-time data exchange is alive and well. But it has not been possible with existing technological solutions (barcodes, RFID, or WiFi).

RuBee Visibility; Process Free, Automated Data Entry

RuBee is a new disruptive wireless technology (IEEE 1902.1) based on magnetic waves that work in harsh environments.

RuBee has several key advantages over other wireless data gathering technology

- Long battery life: 2 to 15 years.
- Long range: 10-20 feet with volumetric reading areas.
- Performance not affected by liquids, people, or steel. In fact, steel can enhance the signal.
- No known human safety issues, no known pacemaker or ICD EMI issues (see 4 Mayo Clinic Study).
- Reviewed and classified by the FDA as a Class 1 NS (see 6).
- No known EMI or EMC issues with mission critical hospital equipment.
- High Security. No known security issues, eavesdropping proof, with optional high packet security.

RuBee is a recently balloted IEEE standard (P1902.1) and is in widespread use at the Department of Energy, Department of Defense, on Weapons and Handguns, real-time asset visibility in mobile vehicles, mission critical tool visibility, and a host of other visibility applications (see Application Examples at end of Document). RuBee is unique in that it is not line-of-sight and provides automatic data collection with no user process change. RuBee provides data automation and collection without manual steps, and can deliver the process free data entry for patient flow, people flow, and mission critical asset management within a hospital. Preliminary data suggest that RuBee Visibility Networks may enhance procedure room throughput by up to 30%, and help reduce billing an invoice costs and loses as well as asset management costs by 20-30%.

The PAVE Project Rationale

The combination of revised and new IT systems, automated data collection using RuBee wireless technology, and a structured hospital staff coaching system has the potential to reduce Hospital costs 10% to 15%. Rationale for cost reduction is simple – Assume a hospital is a simple manufacturing facility with inputs, outputs, and loops. The cost of running the facility and the cost of production is largely proportional to the number of products manufactured per unit time. If "production" can be increased, there is an associated decrease in costs. Management of patient flow, staff flow, and mission critical asset flow (implants, OR disposables, blood) will have a major impact on throughput and cost reduction of any hospital. The RuBee PAVE Project is a model project designed to demonstrate that these savings are possible, and scalable.

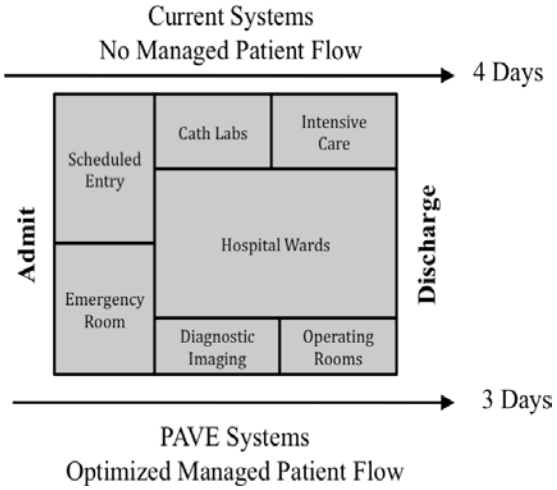

Figure 1 - PAVE Patient flow enhancements have major impact on healthcare economics.

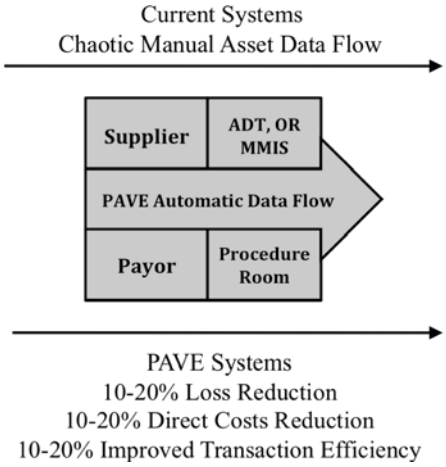

Figure 2 – PAVE Data and Asset flow improvements have major impact on healthcare economics.

Southwest airlines is a good example of people and asset “throughput economics”. Southwest is able to turnaround 2,300 airplanes everyday in under 30 minutes per stop compared to the industry standard of 1-2 hours. That increases passenger flow by 30 to 40% per plane and significantly reduces costs over other airlines. Southwest has accomplished this with special systems that produce real-time KPIs known as SWIFT and TIBCO smart sockets, but also with strong team coaching and constant feedback support and review to maintain maximum efficiency. The key is to provide all key stakeholders with real time performance metrics with KPIs and with emphasis on coaching to maintain constant improvement.

The PAVE Project

The 12 month project is sponsored by Healthcare companies interested in encouraging and supporting cost reduction systems within the US healthcare system. It will equip a single model Orthopedic Procedure room with full RuBee Visibility Systems, as well provide real-time KPIs and flow monitoring data and support consulting services for the staff. The real-time data will be provided through smart socket messaging, and constant metric driven team review. That simply means the systems will produce ongoing, objective flow metrics, and those metrics will be available in real-time, and reviewed on a weekly basis, by all team members. The team reviews will be used to optimize and correct bottlenecks, and any other flow-related issues. The PAVE Project will have several performance targets:

1. Improve procedure room flow by at least 20% (e.g. 20 procedures per week to 24 per week) using RuBee Visibility Networks.
2. Obtain Phase II performance data as an FDA clinical study of the full RuBee Visibility System.
3. Develop methods and rules for coaching the hospital staff to insure constant improvement.
4. Write an independent peer reviewed paper focused on the economic issues and the full on ROI, safety, and other outcomes benefits associated with “1-3”.
5. Produce commercial OR/PR visibility networked systems that can be scaled throughout any hospital to provide similar cost reductions.

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