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Development and Implementation of a Biomedical Information Network

S. Miodownik [1] , P.H. Frisch [2] P. Booth [3]

Abstract - Once the requirement for a Biomedical Information Network has been articulated, the process of development and implementation can then be approached. Although the general architecture of such a system may appear to be self evident, there are careful design considerations that will allow the network to be robust and achieve increased levels of functionality as additional systems come on-line and become integrated into the network. As of this writing, there are few interoperability standards between the various medical systems that comprise the desired network. We have chosen the Emergin Orchestrator product (Boca Raton, Fl) as the vehicle for integrating these systems. The major design and implementation tasks include defining the basic information architecture, assessing the performance of the existing IT infrastructure, and understanding the native capabilities and limitations of each system involved in the network.

1. S. Miodownik is the section leader of Clinical Engineering within Biomedical Engineering, Department of Medical Physics, Memorial Sloan-Kettering Cancer Center, New York, Ny 10021 (212) ^39-8370
2. P .H. Frisch is the Director of Biomedical Engineering in the Department of Medical Physics at Memorial Sloan-Kettering Cancer Center, New York, NY. 10021 (phone (212) 639-8758); fax (212) 717-3010); email: frischp@mskcc.org).
3. P. Booth is the section leader of Surgical Engineering within Biomedical Engineering, Department of Medical Physics at Memorial Sloan-Kettering Cancer Center, New York, NY. 10021
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Introduction

In the ideal world all medical devices and systems would freely exchange information. This data would be available to caregivers, the patient's medical record, and would enhance the level of the patient's care, minimize his hospital stay and improve his satisfaction. The reality is, alas, quite different. There are volumes of information generated by monitoring devices, physician's orders, lab results, nursing notes, etc. In addition there is a flow of alarm information from monitors, ventilators, infusion pumps, with varying degrees of urgency that define the information environment. These inputs and outputs are poorly correlated and inefficiently available to the caregivers in a timely fashion.

We begin with the assumption that an orderly interchange of this information will, if properly managed, benefit the patient. Our institution, as do many others, currently hosts a number of independent medical and information applications that have network components in one form or another.

Existing Systems

Tables 1, 2, and 3 list the various systems our institution currently, or soon will, utilize. These have arisen largely independent of each other, yet all are interrelated in providing patient care and safety. The flow of information between these systems is achieved by a variety of relatively laborious and manual processes.

Patient Bedside	Network
Nurse Call	Private, Proprietary, Per Floor
Physiological Monitoring/Telemetry	Private, Ether net, UDP
Ventilators	802.11 Wireless, Web Based
Wireless EKG carts	802.11 Wireless, Web Based
Wireless Infusion Pumps*	802.11 Wireless, Web Based
Vital Signs Monitors*	802.11 Wireless
Blood Glucose Monitor	Manual Download

Table 1. Bedside Devices and systems(* future implementation)

CPOE carts	802.11 Wireless, Web Based
EMR (labs, pathology, etc)	TCP/IP Ether net, Web Based
MUSE (EKG archive)	TCP/IP Ether net, Web Based
PACS	TCP/IP Ether net, Web Based
Pharmacy System	TCP/IP Ether net

Table 3. Clinical information Networks

Ancillary Systems	Network
ADT System	TCP/IP Ether net
Staff List	TCP/IP Ether net, Web Based
Vocera Voice Communication	802.11 Wireless, Web Based
Medical Equipment Inventory	TCP/IP Ether net, Web Based
RF-ID Locating*	TCP/IP Ether net, Web Based

Table 3. Ancillary Networks for operational support
(* future implementation)

Examining Table 1, we see real time data acquired directly from the patient, or in the case of ventilators and infusion pumps, therapy delivered to the patient. All of the bedside systems speak to their dedicated central equipment. Patients have to be manually assigned to a device and a caregiver The information is routed to dedicated central stations or servers that maintain this information in various formats. Each of these bedside systems provides information that is important for the patients overall medical record. Additionally they issue a wide variety of alerts and alarms that indicate some immediates situation that requires a caregiver's response. The communications pathway for these alerts is through intercoms situated in the patient's rooms and corridors or dedicated pagers for the assigned staff. Compilations of these alerts, and some of the physiological data, are available, for a time, at the central stations of each of these systems. Only a small portion of this voluminous data flow ever reaches the patient's medical record. In the case of an adverse event, reconstruction of the surrounding circumstances is sketchy at best. Integration of these systems has been attempted in the past. For instance, tying ventilator alarms into the Nurse call system. Such approaches usually yield a high rate of undifferentiated alerts that overwhelm the caregivers.

A Structured Solution

Figure 1 indicates the overall architecture that we will implement to access the information from the disparate systems. Emergin (Boca Raton, FL) has interpreted the data and alarm flow from the various bedside systems The Emergin Orchestrator collects information from the gateway computers that interface to each of the native systems. By collecting the outputs of the various systems it is then possible to time stamp the information and provide an event history that crosses the various systems. Additionally, the Emergin communications gateway (ECG) can forward these alarms to a common communications device. In our institution we have chosen Vocera, a 2-way wireless 802.11 telephone as the common communications device replacing a host of different pagers. The Vocera telephone also provides a message receipt trail that can be used for QA auditing. These processes require the facility to associate patient, device, and caregiver, and equally important, the ability to dissociate equipment and caregivers from the patient. Currently this is done manually. These first steps will lay the foundation for a more robust and interactive Biomedical Information network.

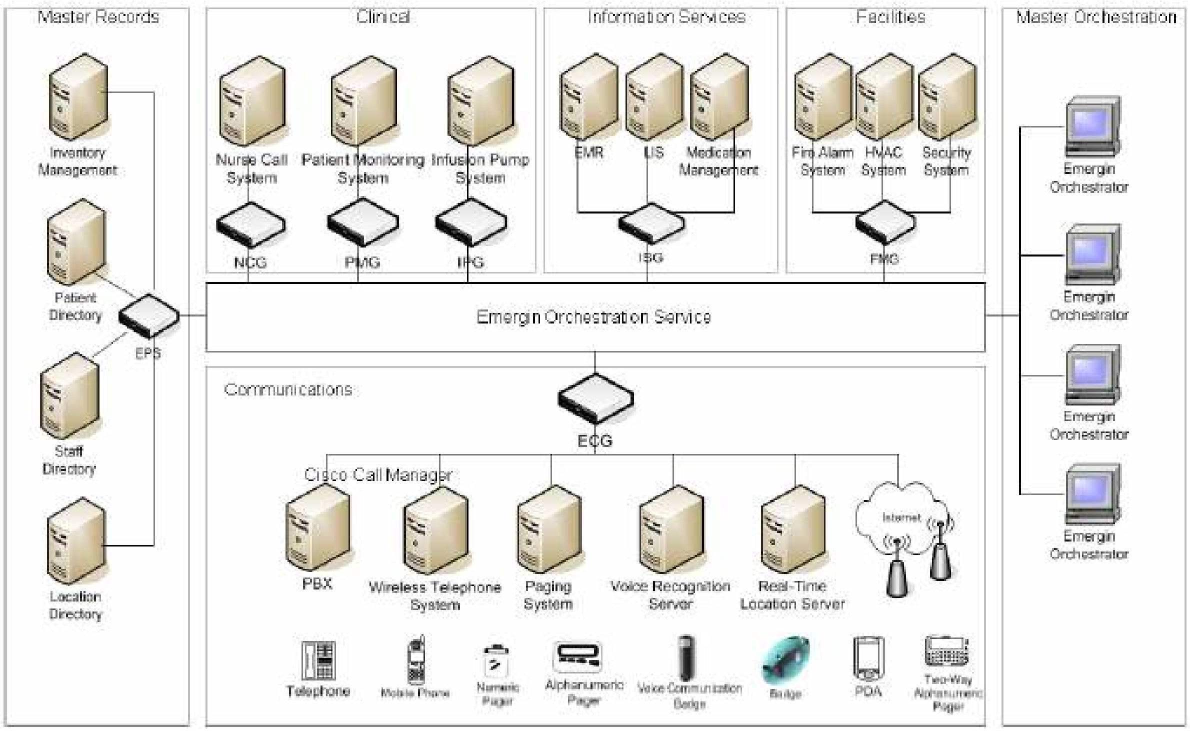

Fig. 1. Biomedical network architecture. Note that each system interface is handled via an Emergin gateway that serves as a data translator from/to each native system

Next Steps

The Biomedical Information Network, as implemented thus far, has limitations. The next logical step is to enhance the functionality of the system by automating several of the required processes and provide outputs to the Clinical Information systems in Table 2. This can be accomplished by the use of the ancillary systems in Table 3. Access to the Hospital's ADT system provides a list of all patients as well as their room assignments. The staff list provides error free identification of the caregiver.

The Medical equipment inventory database positively identifies each clinical device. The association can then be driven by a bar-code scanning process that refers to these three lists. In a more advanced implementation, RF-ID locating has the potential to automate the association and dissociation process by establishing proximity of the patient caregiver and device. In addition, useful metrics regarding availability of devices, response time of staff, and location of patients becomes available for analysis. As additional bedside systems come online (e.g. vital signs monitors, wireless infusion pumps) their information (alarms, data) can be routed routed to caregivers as well. A significant effort in terms of alarm processing must be undertaken as well. An unfiltered flow of alarms in this configuration would be provide no advantage and eventually inure the staff to most alarms, nuisance or otherwise.

The final step of the Biomedical Information network would be for the collected and filtered information to flow seamlessly inot the patient's medical record, so that it would be available in virtual real time to clinicians.