Infinity® OneNet Architecture

One wired and wireless patient monitoring network running on a shared hospital network infrastructure

Abstract

When evaluating the network requirements for a patient monitoring solution for an institution, patient monitoring vendors have typically required a separate, dedicated network infrastructure for their monitors. The purpose of this requirement was to make sure that "life critical" data from the patient monitor would always get through the network. Using common network segmentation techniques and Quality of Service (QoS) principles, Dräger Medical's patient Infinity® OneNet solution removes the need for dedicated networks and lets hospitals make the most of their existing network infrastructure, both wired and wireless.

Infinity OneNet is Dräger Medical's innovative approach to implementing "life critical" patient monitoring networks. Infinity OneNet is both a network architecture and a comprehensive suite of professional services that allow the existing network to provide patient monitoring in parallel with commercial and administrative needs. This white paper focuses on the details of the Infinity OneNet architecture and discusses how it enables the deployment of the Infinity system on a common network infrastructure.

Infinity OneNet Network Architecture

Infinity OneNet consists of the physical network infrastructure and a number of wired and/or wireless patient monitoring devices that communicate via IP-based protocols. Infinity OneNet is divided into segments containing one or more monitoring units and care units. A monitoring unit is a logical group of beds that provides patient monitoring services – such as alarm annunciation, recordings and remote control to its members. A care unit is a group of beds that have the same hospital-assigned identification (i.e., CCU, ICU, SICU, etc.).

Every monitoring unit within the hospital can be subdivided into care units. For example, an eight-bed ICU and an eight-bed SICU could be tied together in a single monitoring unit, allowing a clinician at a MultiView WorkStation or bedside in the ICU to access the data of a patient in the SICU.

Infinity OneNet accommodates the following three types of care unit/monitoring unit configurations:

a. A single care unit in a monitoring unit
b. Multiple care units in a monitoring unit
c. Multiple care units in multiple monitoring units

Collectively, each monitoring unit can support the following number of hardwired nodes:

- 32 bedside monitors/Infinity Explorer workstations
- 4 MultiView WorkStation central stations and Infinity Cardiology ReviewStation displays
- 4 network strip chart recorders and/or laser printers

As many as 32 monitoring units can be interconnected to build an enterprise-wide monitoring network of up to a maximum of 1024 beds.

For hardwired nodes – such as patient monitors, network printers, etc. – each monitoring unit is configured as part of a classic Ethernet-based switched architecture. Following industry-standard network design practices, each node is connected to a Layer-2 Ethernet switch that implements Internet Group Multicast Protocol (IGMP) snooping to filter multicast traffic. One or more Layer-2 Ethernet switches are then connected to a Layer-3 Ethernet master switch that performs the function of managing the multicast traffic in conformance with the IGMP standard specification.

One or more patient monitors configured with an 802.11b WiFi card can be associated with an individual access point that is connected to a Layer-2 or 3 Ethernet switch.

InfinityOneNet

VLAN-based shared infrastructure that reduces costs and simplifies network administration.

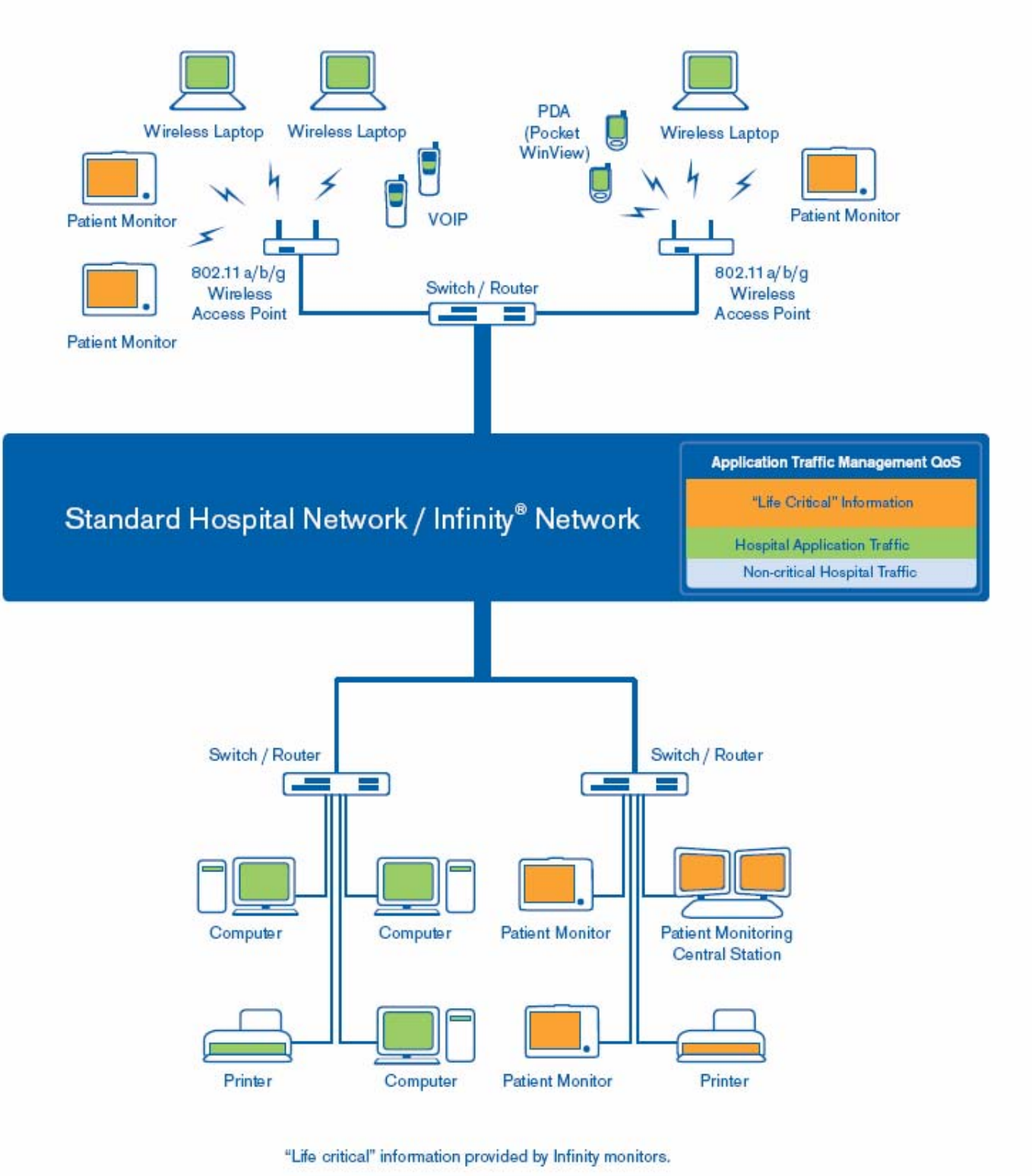


Figure 1: Infinity OneNet Topology

The MultiView WorkStation that can serve as a central station display is treated simply as another network node. This architecture maximizes the performance and reliability of the network and minimizes the possibility that the failure of one node will affect other nodes within the monitoring unit.

The combination of a switched architecture and the communications protocols employed at this level of the network are designed to fulfill four requirements within the monitoring unit:

1) A continuous, real-time stream of data
2) Delivery of messages and/or alarms
3) High performance
4) Efficient use of bandwidth, to make sure that there is adequate network capacity for all messages and alarms

Integration Services

When using a shared network infrastructure for Infinity patient monitoring, Dräger Medical can provide enterprise network services in cooperation with industry-recognized network services providers with whom we have formed strategic alliances. This portfolio of services is designed to help hospitals integrate patient monitoring with the IP-based hospital network – across both wired and wireless domains. The services are structured to help hospitals address their networking concerns and to provide assistance with safety, reliability, security, implementation and support.

To facilitate these service offerings, provide maximum flexibility, and help control costs, Infinity OneNet Enterprise Network Services are structured in a modular format and include the following:

- Certification and Validation of Network Components
- Network Capacity and Technology Assessment
- Performance and Quality of Service (QoS) Assessment
- Wireless Site Survey and Modeling
- Network Implementation
- Wireless Security Assessment
- Network Support and Management
- Infinity OneNet Education and Training

Full support for VLANs – wired and wireless

Infinity OneNet provides full support for VLAN configurations for both wired and wireless patient monitors. Overall, the configuration rules for monitoring units apply to VLAN configurations with the following additional requirements:

1) The Infinity Network must be configured on one or more VLANs that provide logical isolation from the remainder of the network. See the *Shared Wireless Infrastructure* section of this document for more details about the configuration of wireless VLANs.

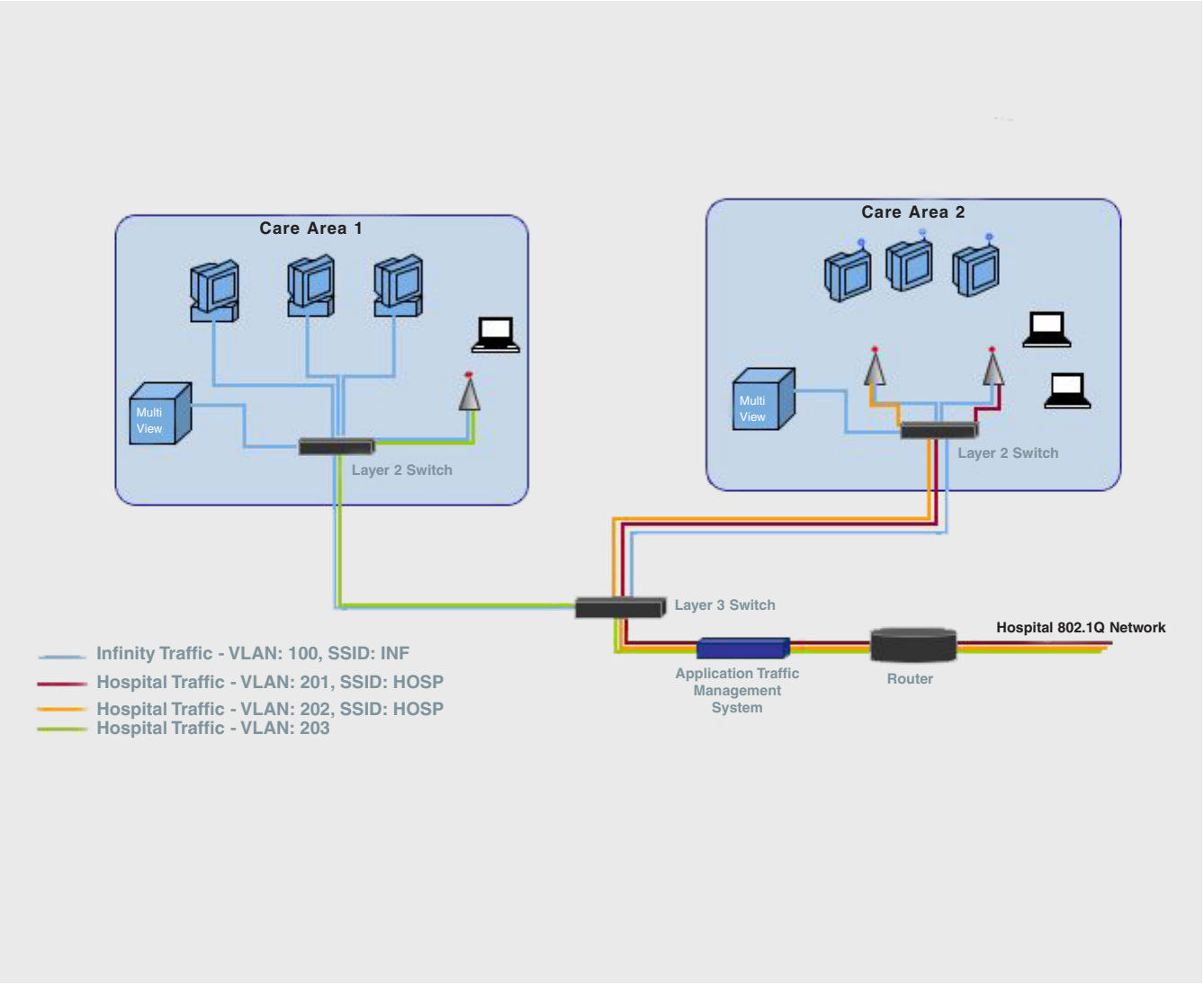
2) When wireless monitors share the hospital's WiFi network infrastructure, an application traffic management device (i.e. PacketShaper from Packeteer, Inc.), is required to provide Quality of Service (QoS), the necessary bandwidth and priority for Infinity patient monitoring network traffic. A detailed wireless site survey is required to determine the current and planned wireless capacity, the coverage to provide QoS for patient monitoring, and the relative priority and QoS for all other wireless applications used in the hospital.

Timely information access

When traveling over the network, waveforms must arrive at the central station or remote monitor in near real-time (1 sec). Any delay can either result in a loss of synchronicity between the various parameters displayed or cause the display to blank out.

The Infinity Network routes patient status data continuously, in real-time, and waveform data on request to all nodes in the monitoring unit. Because the data is multicast, Infinity patient monitors and MultiView WorkStations can display the same waveforms generated by any bedside monitor in the unit without multiple transmissions. Caregivers at one monitor can view waveforms of any other in the monitoring unit by selecting a bedside's name from a drop-down list. Caregivers at multiple bedsides and at the central station can view the same information simultaneously.

IV. Infinity Wireless Patient Monitoring VLAN Topology



V. Providing Quality of Service (QoS)

As with wired LANs and other networks, WLANs can leverage Quality of Service capabilities to enable prioritization schemes for traffic types, geographic locations, and specific individuals or departments. In a "life-critical" patient monitoring environment, QoS is imperative. Dräger Medical has chosen a methodology that will allow the primacy of patient monitoring data within a wireless infrastructure. In order to accomplish this goal, Dräger Medical has employed an application traffic management (ATM) system from Packeteer, Inc. – the leading provider of application traffic management solutions worldwide.

Moving patient monitoring data through the network
Dräger Medical uses the Packeteer PacketShaper® to deliver critical patient data from the monitor across the network – even when an access point is extremely busy or completely saturated with non-Infinity traffic. PacketShaper is an intelligent network appliance that dynamically controls the bandwidth and priority of critical patient monitoring data as it is transmitted through various access points and routed onto the wired network. It does this by regulating the "shaping" of all non-critical wireless traffic, thus controlling the radio airspace of each access point.

A powerful QoS feature of PacketShaper is its rate control capability. This feature effectively limits and contains applications that share the wireless network, protecting the flow of data for wireless Infinity patient monitors. PacketShaper can fit seamlessly into a hospital's IP network and is typically installed inline between the wireless and wired segments of the network. In this

Support of hospital IT architectures and protocols

A key to success for Infinity OneNet is its adherence to standards at every level of the communications hierarchy. Because it communicates via standard networking protocols, Infinity OneNet can send and receive data over many different types of hospital local area network infrastructures – in most cases, regardless of vendor or actual network medium. For example, Infinity OneNet supports network configurations and/or equipment from leading network vendors such as Cisco Systems. Additionally, compatibility can be established with copper, fiber optic, and wireless media and technologies. Institutions that choose Infinity OneNet are not limited in their choice of IT providers or technologies.

Quality of Service in the Shared Wireless Infrastructure

Deployments involving shared wireless infrastructure can leverage QoS capabilities to enable prioritization schemes for traffic types, geographic locations, and specific individuals or departments. In a "life critical" patient monitoring environment, it is imperative that QoS be provided. Dräger Medical has chosen a methodology that optimizes the primacy of patient monitoring data within a wireless infrastructure. In order to accomplish this goal, Dräger Medical has employed an application traffic management (ATM) system from Packeteer, Inc. – the leading provider of this technology worldwide.

Dräger Medical uses the Packeteer PacketShaper to optimize the delivery of critical patient data across the network – even when an access point is extremely busy or completely saturated with non-Infinity traffic. PacketShaper is an intelligent network appliance that dynamically controls the bandwidth and priority of data as it is transmitted between access points and the wired network. It does this by processing all the wireless traffic, both from Infinity and non-Infinity devices. The drawing on page 2 illustrates the role of the application traffic management device.

PacketShaper is configured to provide bandwidth specifically for Infinity traffic, on demand, as one or more wireless Infinity monitors are added to the wireless network. When the number of wireless Infinity monitors decreases, PacketShaper frees up bandwidth to be used by other hospital applications. PacketShaper does not waste bandwidth by permanently pre-allocating a set amount.

Another powerful QoS feature of PacketShaper is its rate control capability. This feature effectively limits and contains applications that share the wireless network, while simultaneously protecting the flow of data to and from wireless Infinity patient monitors. PacketShaper can fit seamlessly into a hospital's IP network. It is typically installed inline between the wireless and wired segments of the network. In this configuration, PacketShaper is able to effectively parse and control all wireless traffic, giving precedence to patient monitoring traffic without the loss of other wireless data.

Conclusion

Hospitals today can meet the unique challenges and requirements of the hospital network environment through an industry standard, open and innovative approach to patient monitoring network design. There is no longer a need to restrict patient monitoring to dedicated and/or proprietary networks. As an enterprise-wide patient monitoring network, Infinity OneNet opens up a whole new world of flexibility, reliability and economic efficiency.

Infinity OneNet enables seamless switching between wired to wireless patient monitoring. It provides ease of use, economy of implementation, and a high level of expandability. It affords the possibility of full patient monitoring within the hospital enterprise and beyond.

By adhering to industry standards at every level, Dräger Medical has optimized the efficacy of the Infinity patient monitoring system in today's heterogeneous, multi-vendor environment. By using the hospital's existing network infrastructure, Infinity OneNet enables hospitals to take advantage of existing processes and tools for all aspects of network management. Standard network protocols make Infinity OneNet reliable and maintainable. By complying with industry standards, Infinity OneNet is designed to meet the evolving patient monitoring needs of hospitals today and into the future.

Published by Draeger Medical Systems Inc., Jan 2006.

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