Building high density networks for use in clinical environments

This whitepaper discusses the best approach to wireless network design and deployment in a hospital and clinical setting.

Wireless network design for larger Healthcare Enterprise Networks has become more complex as wireless becomes a mission critical part of the delivery of patient care.

Because of this Motion has created a four phase approach to wireless network design that includes the building, end user, wireless devices and the network. All areas are considered in their component parts and as a whole before any design is completed.

This methodology is proprietary to Motion and is highly effective. We have designed and implemented over forty million square of high density in hospital wireless networks and our success rate is 100%.

Hospital and Clinical Care Wireless Networks have two major differences from most other types of wireless enterprise networks.

First, they are considered mission critical, meaning that most of the business conducted over them can radically alter the quality of life and the delivery of critical patient care.

Second, they need to be highly secure; there is a large amount of information that is transmitted over these networks that is required by many regulatory agencies and the Federal Government to be kept highly confidential.

This creates a real challenge in environments where there are multiple parties responsible for the outcome, tracking and managing the data that drives patient care decisions. The hospitalist and clinician view is that patient care is paramount, and rightly so.

Clinicians have grown used to the reliability of the wired network, however, with the use of ubiquitous wireless deployments, the data that can affect significant decisions is being sent over wireless networks that have traditionally been less than reliable compared to wired connections.

Mission critical is often defined as being crucial to the outcome of the task at hand. In a lot of networking scenarios this could be defined a lot more loosely but in patient care environments small errors can create dire ramifications possibly including loss of life.

Therefore in a hospital environment, “mission critical” can be defined as anything affecting the delivery of patient care. In the end this boils down to having the ability to make a critical decision based on the accuracy and / or timeliness of the information on which the decision is based.

How wireless networks are normally designed

There is a tremendous amount of information about the correct way to design and manage networks in healthcare. But most of this information is based upon trying to get the most throughput and best quality of service out of a network, based on the same design principles as any large corporate network.

This belief is present throughout the wireless networking community and is reinforced by the wireless network hardware vendors as well as a lot of wireless network engineers. This can lead to significant performance issues that are usually overlooked and tolerated as normal in most non-healthcare networks but are not acceptable in healthcare.

The typical, traditional way with site surveys and network designs are created are based on the "AP on a stick" type surveys that examine what the RF propagation would be if an AP was placed in a particular location and signal strength measured off of the survey AP. A test access point is placed on a cart attached to a power source and wheeled around the building. It is then strategically placed where an AP is thought to be needed and measurements taken from it.

Typical AP on a stick:

These measurements from temporary AP placement then drive the overall design. This survey data is then coupled with the obvious areas of RF interference such as brick walls, metallic objects and so on, and then a design is put together that provides a minimum signal strength measured in received signal strength, (RSSI), in areas where wireless coverage is expected.

This may or may not be augmented with some additional RF signal density for better coverage in some areas considered to be lacking or needing extra coverage based on specific device needs such as VOIP badges etc.

Additionally, when the obvious expense of deployment and other issues including regulatory compliance and State and Local permitting issues, (which can include things such as infection control and fire and safety concerns), are factored in, it can, and almost always does, limit the effectiveness of good network design.

Lastly, it is not unusual for hospitals to have many different vendors provide input and in some cases specific requirements. There may be a vendor that is providing a specific device that has certain RF requirements, or there may be a software vendor that requires that the network be validated prior to deployment. These vendors will often provide or ask to do their own survey. Unfortunately this is often done in a way that causes detriment or at a minimum disruption in the way the overall network is performing.

It is not unusual to be in a part of a hospital building and see signal coming from access points on one, two or three adjacent floors, often with a transitory but usable signal.
When a device connects to this AP the connection may only last a short while because of signal face thus causing a disruption in not only the floor the device is on but potentially the floor the AP is on.

Because of this often conflicting array of agendas and design principles it is not uncommon to inadvertently drastically degrade or even compromise an existing environment or put in place a network that is inadequate for today's needs and future growth of mobile device usage.

Motion Clinical Design - Designing Mission Critical Networks for Patient Care in hospital environments

Motion applies a different approach to the unique challenges that Healthcare Environments have. One that brings together all the segmented physical and logical layers of the end to end patient care experience and provides a top-down best practices design and implementation process.
Because of this t is important when designing a hospital wireless network that the entire ecosystem of a hospital is considered and taken as a whole and not merely as a sum of its parts.
When discussing network design with a prospective client it is common in almost all cases to be given a list of areas which they consider to be critical areas and then areas where coverage would be nice to have but not as necessary.

This usually implies that the investment in "non-critical" areas will come later or be of secondary consideration, or even have a different design and requirements. This is a fatal flaw that severely limits use of wireless networks and device effectiveness throughout the entire hospital at the very time where network usage is expanding at the fastest rate ever.

The Motion Clinical Design methodology accounts for all areas of present and future coverage so that when the secondary deployments occur the network is able to perform in a measured and predictable manner without a re-design or performance loss.

This design methodology accounts for the priority of clinical importance and a high level of security and needs based availability. Additionally this network design methodology uses design and implementation criteria that will provide a high degree of certainty of outcome.

Therefore, once implemented the network and all of its parts work together to provide a higher degree of overall patient care delivery and care giver confidence and satisfaction, this results in a lower expenses and higher retained revenue for the entire business.

This means that the business invests less in the overall network, saves more money in the long term and has a much higher level of end user and customer satisfaction. The additional effort provides a huge ROI compared to less complex and archaic design methods.

This will be the focus of the rest of this paper, how to properly design and implement a wireless network that is secure, available and supports all the devices and applications that use it.

Overview of the Clinical Informatics landscape

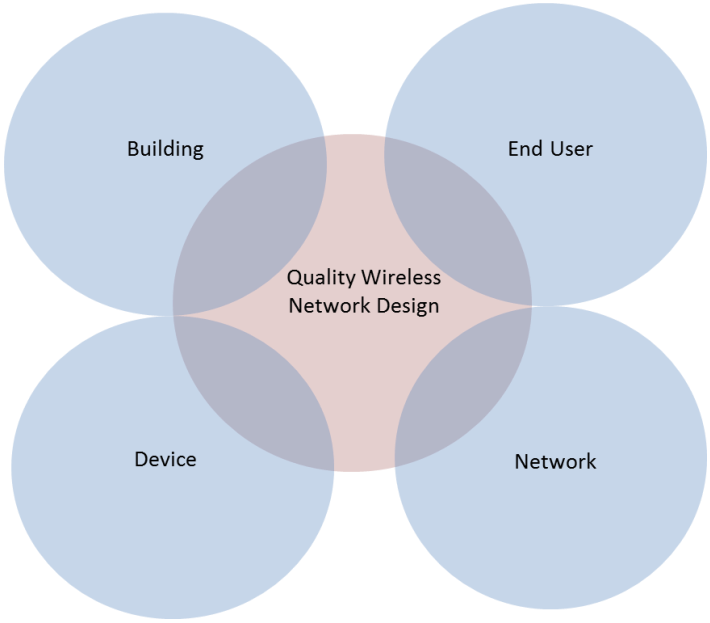
When discussing a mission critical network in healthcare it is important to understand the role the network will need to play in entire Informatics landscape both from an application, device, clinician and patient care perspective. The wireless network is just a part of the end to end delivery mechanism in these environments but it is often the most difficult to design and certainly the hardest to troubleshoot and diagnose.

It is not unusual to have dozens of different devices and literally hundreds of applications being used at any one time. In addition to the overall environment specific patient care areas have their own requirements and challenges. Not accounting for these "special needs" areas can severely affect the outcome of even large multi-million dollar deployments of Enterprise Patient Management Systems.

Additionally, highly regulated security policies and application access concerns within healthcare networks are daunting. They include, patient confidentiality, device security, network security and authentication and access control usually not seen outside of military and government security requirements. This is not the case with the normal business enterprise network.

This is probably the most misunderstood areas for most Wireless Network Architects, why is a hospital design have to be any different from any other network when it comes to wireless network design?

Four different critical wireless network design areas:



By taking into account all of the areas that are mentioned above and by properly planning the layout and design of the network so that the entire ecosystem is considered during the design. A quality scalable enterprise wide wireless network can be implemented.

1. Physical Building Considerations- This can be the most challenging of any of the areas of consideration due to the way those hospitals; especially older hospitals have been built.

2. End User Considerations- In today's hospitals almost everyone wants to use the wireless network. It is surprising how many of these users are not taken into account when providing performance baselines for the network design.

3. Device Considerations- There are a whole array of devices that use the wireless network, both fixed and mobile and they all have an effect on how the network performs.

4. Network Use Considerations- One of the factors that needs to be considered is how the wireless network affects the overall performance of the rest of the network.

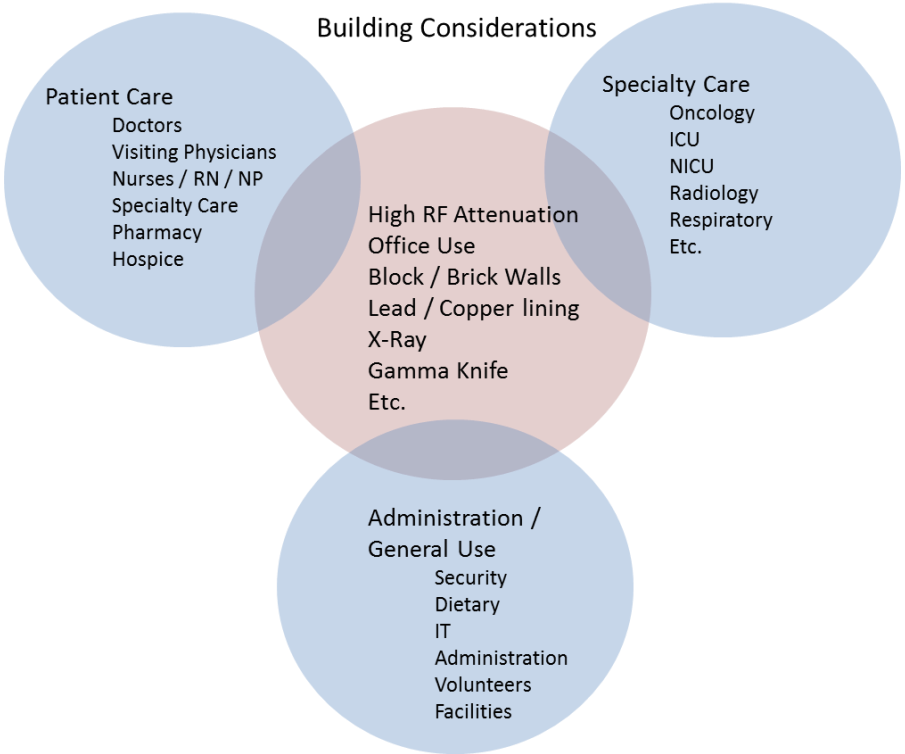
Physical Building Considerations–

The most important factor in analyzing a building and laying out the RF necessary for a specific area is to make sure that the user is not able to roam away from the network resources that they should be using. This seems straightforward and in main hallways and other areas this is not a problem. The issues arise from low or fringe coverage areas. The best example of this is the fact that in patient rooms it is not unusual to have a signal from another floor conflict with current floor because of signal attenuation from AP's that are supposed to provide service. This is a common occurrence.

Generally, new construction had the least amount of issues but still it is not unusual to have many areas that are very hard to design for, radiology, oncology, BIO medical areas, operating rooms, autoclaves, labs and other areas all present their own set of challenges.

It is not unusual to have brick, block, wire mesh or other RF inhibitors within older buildings. Additionally these types of building materials are often covered with Sheetrock and look and feel like standard metal stud sheetrock walls.

Almost all stairways and elevator shafts within buildings are made of concrete, block or brick additionally it is not unusual to be prohibited by local fire ordinance to place Access Points or network cabling in these areas.



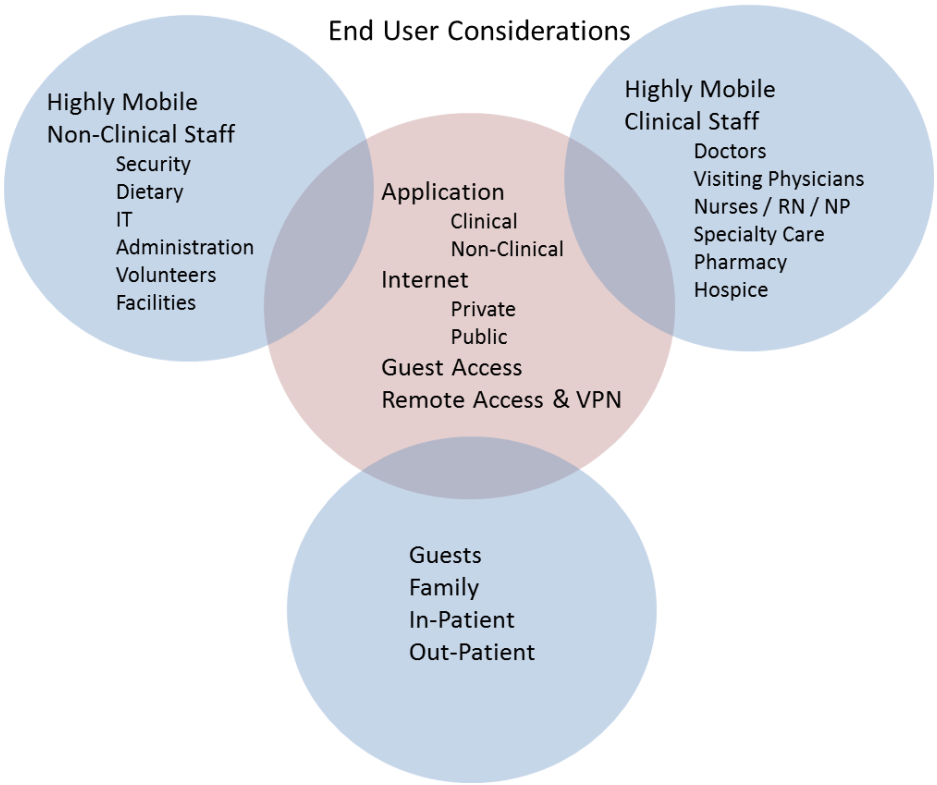
End User Considerations –

End user experience varies dramatically within a large hospital deployment. Some users are highly mobile and some spend their time in the building in a fairly small area. Roaming considerations and ability to stay connected during a period of time have different meanings for a nurse in a Critical Care Unit as opposed to a Pharmacy Technician.

The Critical Care Nurse may not need to leave an area that may only be around 1000 square feet depending on the amount of patients he or she has. Additionally they may only access data from a computer on wheels and fixed PC's that have a dedicated network connection.

The Pharmacy Technician on the other hand may be dispensing, stocking and verifying medications throughout several floors or every patient care area including the Pharmacy Lab itself. The lab is often located in the lower floors of the hospital and away from patient care areas.

These types of workers are highly dependent on roaming network access and often are having to connect and re-connect in all areas because of poor connectivity between network islands created by spotty coverage.



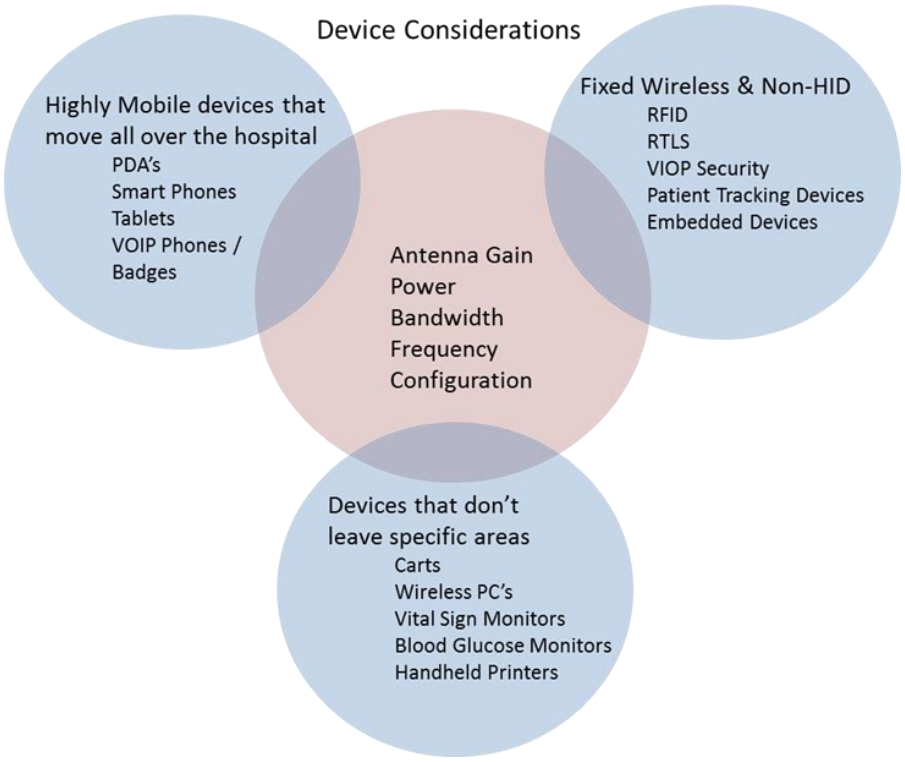
Device Considerations-

Device usage in a hospital environment can be highly mobile and very small with low power and specific signal quality needs such as a Vocera badge or a Blood Glucose Device.

They can also be devices that have good antennas and are able to use full power transceivers and do not move much during the day except perhaps up and down a hallway an example of this would be a computer on wheels.

Additionally, there are a lot of fixed wireless devices that are part of the wireless ecosystem but require little or no human interaction. These types of devices are IDS and Video surveillance devices, embedded wireless devices on infusion pumps and RFID/RTLS devices.

Lastly the patient and family are placing an increasing load on the hospital networks as they use these networks for data, e-mail and sometimes voice and video services.



Network Considerations-

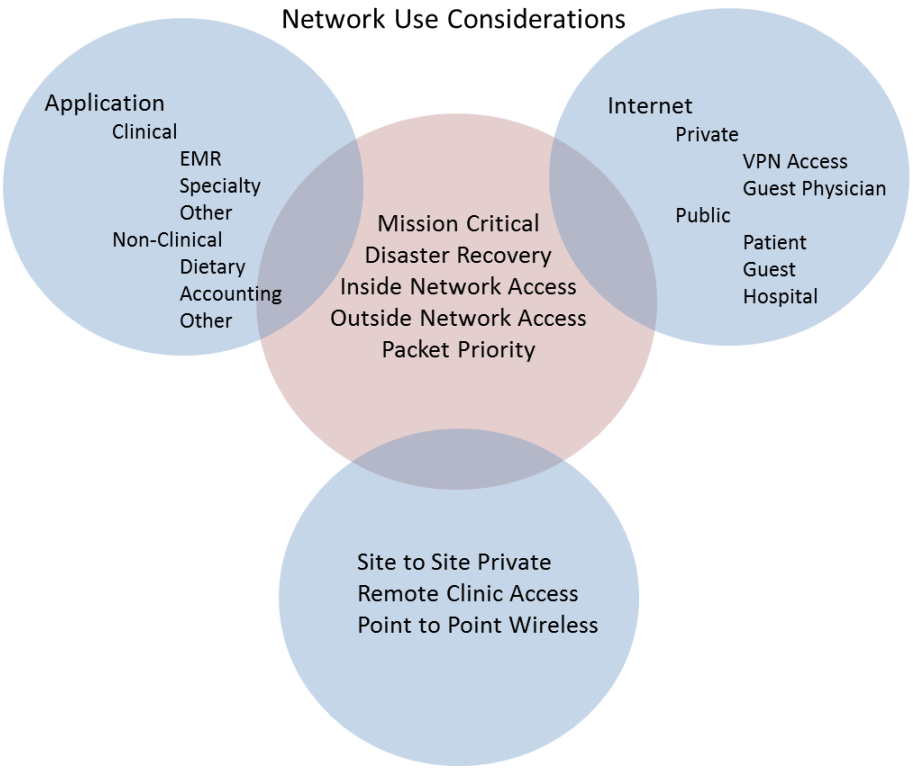
Basic analysis of network utilization used to be very simple. The Network Architect would place a switched segment for each wired device on the network; this guaranteed a specific, measureable throughput in all areas that connectivity was needed.

This evolved into a providing wireless coverage as a "secondary" or non-mission critical use case. Usually the fallback to bad coverage was to provide wired PC's or network ports for backup if wireless was used for production applications.

Today's network deployments have to consider the fact that the wireless device is the primary network device for critical network services. Additionally, the shared nature of wireless networking means that different metrics need to be applied to port utilization as many devices could be attached to a single access point.

Therefore a single back-end network port, no longer having dedicated network bandwidth per device but has to be shared amongst all devices that use the access point.

It is important that all devices and applications as well as bandwidth requirements become a part of the quality of service matrix that are used to determine the wired and wireless network ecosystem.



Network Vendor Considerations-

The wireless network space has been evolving for a considerable time with network vendors who offer infrastructure components claiming to have different parts and pieces of the solutions and some of the vendors claiming to have a complete solution.

Additionally the entire network eco-system seemed to be converging into a few companies like Cisco, Aruba and Meru as perhaps the biggest players. These companies were able to squeeze out the competition and create what looked like a pretty insurmountable advantage.

This is still true to some extent but there are a couple of interesting things occurring in the marketplace that may be heralding a more diverse landscape into the future. Companies like Airtight, Aerohive and Meraki are making inroads into enterprise networks with cloud based management interfaces.

A lot of this is centered on cost and basic functionality, but more often it is based on the ease of implementation and deployment scenarios that favor the less tech savvy systems administrator. Additionally overlay networks are becoming common place and these network overlays, for good or bad, tend to drive a lot of change into the ecosystems.

However the one thing that has not changed is the reality of a specific amount of throughput and a specific density based on proximity to other network RF resources that cause a network to only be as good as the sum and arrangement of its component parts.

This being said it is often very easy to confuse the types of overlay functionality and the underlying RF engineering and therefore create a promise of less is more or more is better without properly understanding what the basis needs to be in the first place.

Therefore the component parts of the network can work against each other and actually cause disruptions and / or failure of core network services and a lack of understanding of how to fix them. This is a real problem because it is no longer just network access but more and more the wireless network is part of a foundational piece of technology, along with the basic traditional layer 2 and 3 services of switching and routing that make up the building blocks upon which mission critical network services are being delivered.

Conclusion-

Wireless network design for larger Healthcare Enterprise Networks has become more complex as wireless becomes a mission critical part of the delivery of patient care.

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