MAMAS

International

Technical Description Document
4.26.07

1. Technical Description

The document defines a mobile and fixed telehealth system to provide improved health care in locations not adequately served by traditional health services for a variety of reasons including remote location, lack of infrastructure, or poor capacity in the existing health care system.

The modular system is defined either to provide a complete, turnkey system for delivery of health services or to augment existing systems through the integration and implementation of only the necessary elements into the existing system.

This system will encourage the use of electronic records for all information. A major component of this system will include localization of any information to allow for content to be delivered in the local language and accommodation of special needs like illiteracy.

There are several telemedicine systems in existence and under development as this system is being designed. Every effort will be taken to incorporate existing systems or technologies to avoid duplication of effort.

Standard interfaces and OTS (off-the-shelf) technologies will be used wherever possible. Web-based interfaces are preferred in general over custom applications due to the ease of maintenance and proliferation of standard tools. Networking communications will be delivered using IP (Internet protocol) based applications.

The goals of this system include the following:

- **Improving public health by allowing the collection of data in remote locations, its transmission to central processing facilities, the processing of data to extract desired information, and the dissemination of raw data and post-processed information to multiple locations including the location of origin.**

- **Improving clinical health care through the development and broadcast of training programs for health care workers and education programs for patients.**

- **Improving clinical health care through the use of communications to allow rural health care providers to benefit from remote facilities and interaction with remotely located health care providers.**

- **The creation of an electronic medical records database for each deployed system based on geographic region. This is especially important for patients currently without access to any medical care**

- **Facilitating the efficient use of resources including equipment, medicine and even food through tracking, inventory and mapping applications.**

1.1 System Architecture

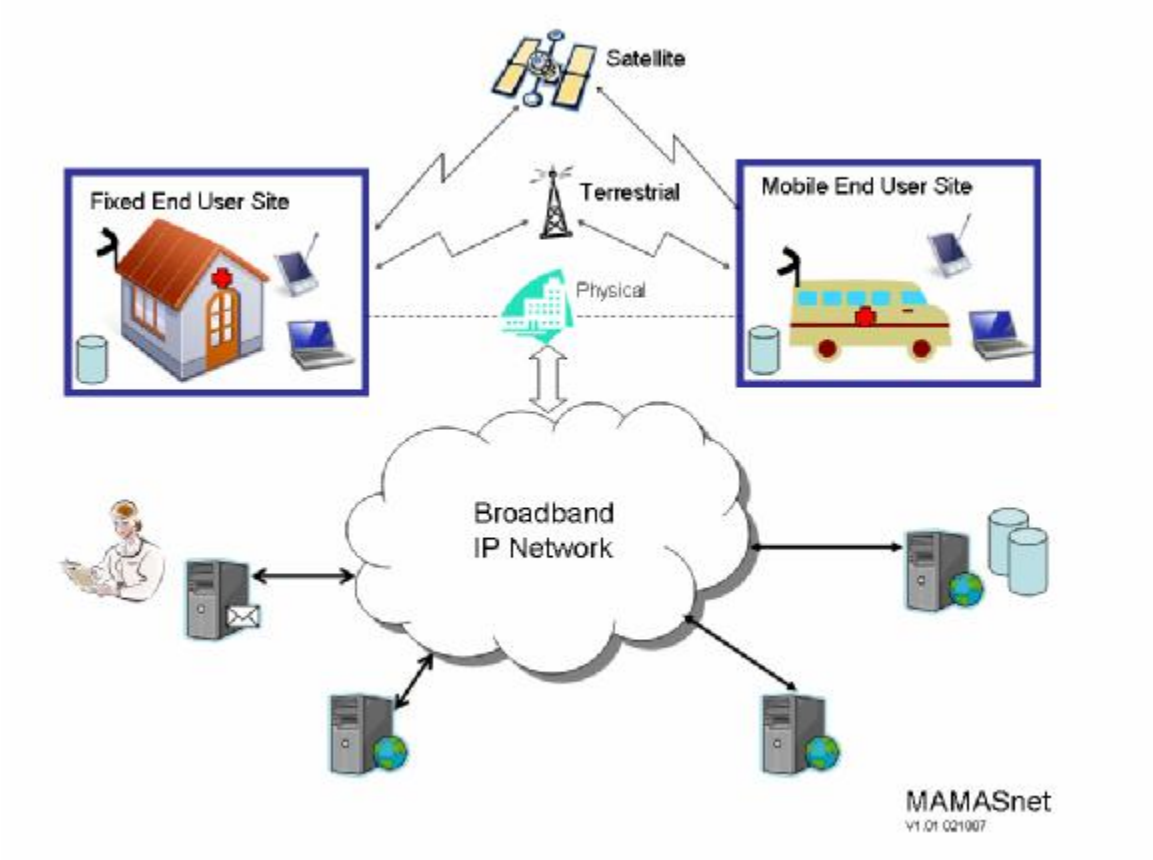

Figure 1. MAMASnet overview

The MAMAS telehealth system consists of many network elements and connecting infrastructure. Patients are attended to by End Users. End Users have been trained to provide telemedicine services to the patients including education, clinical services and distribution of supplies. At the End User location there is End User Equipment (EUE) to provide data collection, storage, control and access, and End User Communications Equipment (EUCE) to send and receive data in real-time or non-real-time using electronic means. If no electronic communications are available, data may be physically delivered to a point connected to the network, e.g. a regional clinic, hospital or university. Additionally, there are medical supplies and equipment (ME) associated with the End Users. The supplies including medicine can be physically controlled and inventoried by the EUE. All EUE, EUCE and ME will be bar-coded and tracked for usage information.

In addition to the End Users, there are many types of network users each given a designation –NE. This signifies that each of these network elements will have broadband access to the Internet or a high-speed private network to allow IP connectivity with MAMASnet.

There are a variety of intended network interfaces including administrators, medical providers and strategic partners. Network Storage Network Elements (NSNE) will be the primary data storage for the program information (user data, medical information, inventory, etc.). These are essentially secure servers (computers) with ample memory. Data will be stored in databases designed for each application and centrally located. The NSNE will store data in a secure way and allow partitioned access to data on a non-real-time basis to many Strategic Partner Network Elements (SPNE) to receive data for analysis and review. SPNEs will include local hospitals and clinics, government organizations, NGOs and Universities. Network Medical Providers (MPNE) will interface directly (through the network) to the End Users for remote medical care and support. Medical Providers are centrally located resources that are shared among multiple End Users. Medical Providers may be a local doctor at a regional hospital or may be a doctor in a pool of available medical professionals available online, but residing all over the world.

1.2 Communications Infrastructure

The bulk of the network communications will rely on existing broadband communications with necessary capacity increases to support MAMASnet traffic. However, the most critical link in the communications infrastructure is the "last mile." The last mile is the link between the End User and the first Point-of-Presence (POP) on the broadband MAMASnet. Service implementation is completely dependent upon available last mile communications. The system shall be designed with a standard interface such that multiple mechanisms for linking the End User with the rest of the network can be employed. The system will be designed to tolerate interrupted data transmission due to issues like poor quality communications. These mechanisms include satellite communications, terrestrial-based communications (cellular, fixed wireless data, etc.), and when no direct links are available, "sneakernet" is used where data is stored then transferred to the network when the End User becomes physically co-located with the POP, i.e. physically bring the storage device to a server and download the data directly. This can take place at regional center such as a hospital, clinic or university. In an ideal implementation, two-way wireless communications, satellite or terrestrial-based, is always available to the End User.

In most parts of the world now there are multiple commercial satellite offerings which can be utilized for MAMASnet. Most are well established geosynchronous systems. Iridium, a LEO (Low-Earth Orbiting) system is the exception. A LEO system has shorter delays in the transmission path for better voice quality and lower power requirements due to its proximity, however, overall expenses are generally higher due to the large number of satellites required for such a system. Satellite communications is a secondary choice for communications with terrestrial systems being the first choice due to anticipated cost and complexity.

Much of the information that is delivered to the patient is not required to be delivered wirelessly over last mile. For instance, multimedia training software or patient education presentations could be physically sent via CD (compact disk) or other storage device. Solid state digitally stored multimedia like MP3 files is preferred over CD if no CD equipment currently exists in the End User sites.

Satellite systems lend themselves well to broadcast distribution of information. Current commercial satellite services include educational material among other data.

This educational data could be tailored for storage and use by End Users in education and training which is a major component in telehealth in remote and rural areas. Cost and complexity of content delivery has to be evaluated at each location to determine which delivery method is most efficient.

Terrestrial systems like a GSM phone network with packet data services would be ideal for delivery of 2-way information. Email, voice and video can be handled via GSM handsets. GSM or similar wireless networks exist in major parts of the world now and the footprint is increasing daily. Some portion of the desired system reach will likely be served by terrestrial wireless systems. Wireless data systems like WiMax are also now becoming more popular with installations lagging far behind phone systems, but increasing very quickly as a cost effective replacement for landline phone and data services in remote areas and areas without sufficient installed physical transmission facilities.

Since it is assumed that communication links to the last mile are a scare resource, applications need to be developed that minimize the information that is sent. Protocols have been developed specifically for use with wireless networks that limit data transmitted, i.e. store main data one time and transmit only changes.

1.3 Data Storage

Data is stored in multiple locations with a master patient database designed to high security and reliability standards. The types of stored data are outlined in Table 1.

Patient records will be stored in accordance with local law and existing systems. If the information collected exceeds existing systems, the data will be stored first in a central mirrored server operated by program administration, then delivered (post-processed) to the local medical community for use. This data is stored in the PR (Patient Records) database. A commercially available EMR (electronic medical records) database may be able to be used for this application. Most of these are designed to US HIPAA (Health Insurance Portability and Accountability Act) standards among others.

All equipment and medical supplies including medicine will be tracked for security purposes and for usage and equipment maintenance information. This data will be stored in a central program Inventory, Administration and Tracking (IAT) database and will be made available to appropriate parties. It is expected that all equipment and supplies will be bar-coded and entered into the system upon receipt. It will be tracked at each new location when moved. Summary data will be available for planning and purchasing purposes.

Medical Support data includes all communications between caregivers, remote caregivers, assistants to caregivers and patients. This could be as simple as a text message or as complex as a video assisted medical procedure. Patient identity will not be disclosed as this data is intended to be continuously folded into a local language knowledge base for increasingly efficient medical care.

All Training and Educational Material (TEM) will be localized to the native language of the patient. Specialized video, audio or pictorial data will be used to accommodate special needs of the users like illiteracy or deafness. Training and educational material will be made readily available as it is developed and will be centrally managed and stored by a program administration or a designated third party.

Table 1. MAMASnet Data

Data Name	Input	Output	Security	Type
Patient Record (PR)	EUE	EUE, NE	High	Text, graphics (photos), Biometrics
ME Inventory	EUE, NE	EUE, NE	High	Text
Medical Support Data	EUE, NE	EUE, NE	Medium	Text (email, IM, etc.), graphics (photos), presentations, video
Localized Training Information (TEM)	NE	EUE	Low	Text, graphics (photos), presentations, video, audio
Localized Patient Education Information (TEM)	NE	EUE	Low	Text, graphics (photos), presentations, video, audio

1.4 Data Security

Data will be prioritized as having one of three security levels within the system: high, medium or low. Patient records and inventory information will be classified as high security and will require encryption and authentication. Standard encryption and authentication will be used within the system.

Medical support information will be categorized as medium secure. Encryption will be required, but not authentication.

Training and Educational information will have low security without required encryption or authentication. Low security data is deemed to cause little or no harm if made public or lost.

1.5 End User Equipment (EUE)

The most demanding mobile telehealth applications will require small, portable data input devices like PDAs or Laptop Computers to operate for long periods of time in rugged conditions without available line power. Battery availability may also be an issue and recharging technologies such as solar chargers will be required for EUE as well as End User Communications Equipment (EUCE).

For ease of use and standardization in training and documentation, all mobile and fixed user location telemedicine applications will use PDAs or Laptops with rechargeable batteries. Some will have available line power while others will require a recharging technology like solar. Applications will be written to be directly portable to either with the same look and feel. Standard applications like web browsers and email servers will be used.

Initially, the interface between the medical equipment and the EUE will likely be manual. Over time it is desired to automate as much of the procedures and data input as possible to increase accuracy and capacity of services. The extent to which this is initially possible will depend upon existing technologies. There are many diagnostic and clinical tools available with electronic interfaces to networked equipment which would be ideal, however, cost and availability has yet to be determined.

1.6 End User Communications Equipment (EUCE)

End User Communication Equipment will consist of the appropriate devices for the location. More than one type of equipment may be available for each location. The equipment is as follows:

- **Satellite transceiver with antenna**
- **GSM or other wireless communications system handset**
- **WiMax or other fixed wireless system transceiver**
- **PDAs or laptops configured with above equipment**

The least expensive, most available communications mechanism will be used. In case of no communications, physical transport will be used. A standardized small footprint, standard interface, data storage device will be selected for this system.

1.7 Medical Equipment (ME)

Medical Equipment covers a broad range from stethoscopes to X-ray machines. It is unlikely that initially anything more than the more basic medical equipment will be utilized in the mobile telemedicine locations. It is the goal of this system to provide increasingly complex and value-added services at both the mobile and fixed sites. This is more easily accomplished at the fixed sites. It is desired that designs be identical for both applications. That does not imply that all services available on a fixed basis would be available in a mobile setting, but rather the packaged equipment and interfaces would be identical. A collection of pre-assembled medical stations will be purchased or developed. These may include carts, suitcases or small racks each configured with medical, computer and/or communications equipment.

Medicine and supplies will be distributed and tracked. The method will depend upon the rules and regulations existing in each location for pharmaceuticals.

1.8 Core Network Elements

1.8.1 Network Storage Network Element (SPNE)

Core network elements already exist at government locations like the CDC, within NGOs and Universities. They consist of computers with databases and programs to analyze and display information among other functions. The main function of MAMASnet with respect to Stategic Partner Network Elements (SPNE) is to effectively integrate with existing systems to provide useful information in the optimum format. In some cases, added capacity or new systems will be required of the SPNE.

Additionally, MAMASnet will receive post-processed data from the SPNE to forward to the User locations to improve processes, for example.

1.8.2 Medical Provider Network Element (MPNE)

It is anticipated that Medical Providers will be linked to patients and End Users:

- **For voice traffic via phone, either circuit-switched (cell or landline) or VOIP (data switched using IP network).**
- **For chat, via standard IMS (Instant Messaging Services) or email**
- **For Videoconference via IP-based video conferencing services**
- **For data transfer like remote radiology via IP packet communications (e.g. GSM packet data services)**

It is desired that communications be stored and organized to provide a knowledge base that is available as a first line of defense for user support.

1.8.3 Network Storage Network Element (NSNE)

Network Storage Network Elements will consist of OTS computer hardware and software that has been configured particularly to service the needs of this application. It is expected that each country or region will have a two physical locations for the PR, ITS and TEM databases, one primary and one backup. It is expected that one site will exist at a central location within the region and another will exist at the site of the program administrator. The data will be nearly identical.

2.0 Services

2.1 Patient Services

Patient services will include education, basic health exams, disease identification and treatment, pre- and post-natal care, pediatrics, and field triage for regional medical centers.

2.2 Local and Regional Medical Services

MAMASnet will interface and work cooperatively with local and regional medical facilities regarding patient tracking and treatment as well as improvement of overall performance of long term goals for the region through feedback of field data and improved use of technologies in the regional medical system.

2.3 NE Information

There will be many partners requiring information for various reasons including follow-up on funded programs, national or international health assessments and reports, and improved product development to service the telemedicine market.

All the system data will be stored on a program basis in a centralized database and will be made available to partners through well-defined interfaces.

2.4 Content Localization

All patient education and training data will require localization. Training and educational material will include specialized video, audio or pictorial data. Training and educational content will be developed as part of the overall program and will be

centrally managed and stored by program administration or a designated third party. Content will be standardized and re-used to the maximum extent possible. All data will be managed with a standard configuration management system.

2.5 Training Programs

Training programs for the system will be developed in conjunction with local groups and training specialists. The information will be handled and stored in the same fashion as patient educational content and also must similarly be localized to the native language.

Training programs will be used to train health care workers on the operation of the telemedicine system and the medical principles necessary to provide and support health care.

3.0 Existing Technologies

All appropriate existing technologies will be evaluated for possible integration, license or inclusion in the system. New development will be performed only when necessary. The following technologies will be evaluated for usefulness and price.

- **Telehealth system software designed for a particular application, but useful in this application**
- **End User Equipment including PDAs and laptops, especially those with telemedicine applications available**
- **Databases – OTS packages as well as commercial products like EMR databases**
- **Standard OS – selection of preferred hardware and software vendors for OTS computer equipment is desirable to get better support and terms**
- **Localization Applications for education and training material**
- **Web-based training creation tools and existing content**
- **Web-based collaboration tools for Medical Provider interface**
- **Medical Equipment especially those made for portable applications**
- **Satellite transceivers**
- **GSM and similar handsets**
- **Wireless data transceivers**

4.0 Phased Development Proposal

4.1 Phase One Initial Design and Proof of Concept

Phase One will consist of the initial Research and Development (R&D). The following tasks will be completed:

- **The initial system design will be completed for a specific target location or multiple locations, and existing technologies evaluated for applicability.**
- **Partnerships with existing technology companies will be evaluated and recommended.**
- **User requirements will be documented and reviewed with participating groups.**

Deliverables will include: (1) Functional Specifications for the system, (2) Interface Definition Documents, (3) Proposal for Use of Existing Technologies, and a (4) User Requirements Document

Budget: to be determined.

4.2 Phase Two Integrated Prototype System (Alpha)

Phase Two will involve the following:

- **Building a single or multiple prototype systems in a central location according to the Phase One design.**
- **Design documents will be iterated to reflect knowledge gained in this phase.**
- **Existing technology partners will be included in the prototype system.**

It is expected that phase two will take 6-12 months with a TBD cost. The cost depends highly upon the cost of existing technology and the amount of new technology to be developed.

4.3 Phase Three Field Trials (Beta or Pre-Production)

Phase Three will include building and testing multiple Beta systems in a central location. Once the systems are tested they will be shipped and installed in the field. Live field tests will be conducted and user feedback will be highly prioritized in the revisions of the system. Design documents will be updated to reflect knowledge gained in this phase. Initial local training and education content must be available for field trials. Production planning will occur in Phase Three.

Cost and duration TBD.

4.4 Phase Four Implementation of System (Production)

Phase Four will include building and testing multiple production systems in a central location according to a production plan. Once the systems are tested they will be shipped and installed in the field. –NE Partners will be added as they join the program. Each interface with an –NE will be independently tested and deployed. Design documents will be updated according to standard configuration management rules to reflect continuous improvements of the system. Substantial local training and education content must be available once production begins.

Cost and duration TBD.