Global Health Grid (GHG)

e-Health Records

e-Health is sought by all countries as a way to contain costs and improve access to healthcare. Unfortunately there have been failures and criticism about ease of use and clinical benefits. This implementation is a simple clinical record with the patients alerts and chronic medication, risks and preferences and short clinical notes for each visit. Unlike other e-health systems it stores handwritten notes and scans as well as digital data.

Scope

This is a global scale application to store Healthcare information for Epidemiology and E-Health. It uses *Cloud Storage and GIS Maps* for storing and retrieving health data using a *Grid system* that defines regions of 42 arc minutes - 80 X 80 Km at the equator.

GHG has two purposes: *e-Epidemiology* and and *e-Health*.

E-Health is information about clinical management. It contains details of treatment, prescriptions and referrals. E-health data belongs to the patient and is stored confidentially in the patient's private e-health record. E-health is stored in a cloud repository that allows patients to access their medical record wherever needed.

E-Epidemiology is information about the diseases occurring in the population: it contains diagnostic codes and other data without recording any person identifiable information. It is used for healthcare statistics, surveillance and planning.

Data Storage

Azure Cloud Blob Storage

Microsoft Azure BLOB (Binary Large Object) cloud storage is used to store all the data according to geographic regions (GIS). There is a separate **storage container for each region** which in turn contains eleven BLOBs: **'P','L','E', I0 ... to I7** as shown in the following table:

BLOB	Purpose	Data Structure
P	Patient e-Health	64 Kilobytes (128 pages) for each patient
L	Loaders (providers)	4 Kilobytes (8 pages) for each provider
E	Epidemiology	All patients for the region (variable length allocated for each day using index table)
I0 .. I7	Images	Ranges from 32Kb to 4Mb in 8 separate blobs

Azure Container Names ('qnnee')

Container names consist of 5 hexadecimal characters defining a GIS region "qnnee" (quadrant, latitude and longitude).

```
nn = degrees latitude / 180 * 256;
ee = degrees Longitude /180 * 256;
q == 0 for NE
q == 1 for NW
q == 2 for SE
q == 3 for SW
```

The "qnnee" values range from "00000" to "37fff" and represent regions separated by 42 arc minutes.

Patient and Provider ID's

Unique ID's for patients and providers are equivalent to their data offset in the 'P' blob or 'L' blobs.

Patient's e-Health data aligns with 64Kb boundaries so the data location in the 'P' blob will be:

```
Start Location = ID<<16
```

Similarly provider data aligns with 4Kb boundaries in the 'L' blob at

```
Start Location = ID<<12
```

Processing

The purpose of the software is to maximise the value of the data. To provide ways to simplify collecting the data and then fully using the data.

Actionable Data / Population Health Management

The design supports actionable data. For example e-health will flag risky behaviour such as missed appointment or vaccination, or diseases such as drug resistant TB. An scheduled cloud process will periodically check all the records in a region and will act by sending an SMS to the patient or email a healthcare visitor to follow up the problem.

Actionable data will help control serious health problems like maternal and child mortality, HIV, road accidents and violence patterns. It will be used for managing telemedicine, health visitors and appointment reminders. This will be done automatically and at low cost.

Scheduled Processing

Azure storage queues allow scheduling of tasks such as appointment reminders on a specific day. For long delays the task could be flagged in the patient's e-Health record as actionable data.

Epidemiology

Epidemiology is possibly the most important application. Before cloud computing and GIS it would have been impossible to collect, process and map geographic healthcare data in real time.

This application gives healthcare providers a simple way to record the conditions they treat every day without person identifiable data. A cloud process could sort and record epidemiology provide updated information overnight.

(This process could be applied on a global scale)

The table shows how epidemiology processing works. Epidemiology data is loaded into one of eight storage according to '45 minute time zones' as shown below. By setting the queue visibility to hide the data until the owner region reaches midnight, each region data has exclusive visibility for 6 hours of processing (from midnight to 6 am).

Processing using Azure Queue Storage and Epidemiology data

queue				
0	0	8	16	24
1	1	9	17	25
2	2	10	18	26
3	3	11	19	27
4	4	12	20	27
5	5	13	21	29
6	6	14	22	30
7	7	15	23	31

Azure Page Blob Storage

Blobs 'P' and L' Patients and Providers (Loaders)

Patient, Provider and Image data are fixed length records and stored at fixed offsets in their respective page blobs. Azure processing provides a useful 'GetPageRanges(offset,length)' method to retrieve the occupied page ranges from specific offsets to guide efficient retrieval and editing.

Blob 'E (Epidemiology):

Epidemiology data is queued and then stored into the epidemiology blob by an Azure Worker Role using a daily scheduled task.

Blobs 'I0' to 'I11' .. (12 image ranges)

Six Kilobyte Ranges: 16,32,64,128,256 and 512KB
Six Megabyte Ranges: 1,2,4,8,16 and 32MB
The idea is to have fixed length records for efficient storage and retrieval and to manage the duration of storage from 1 month to 20 years.

The storage of image data includes an intermediate step to set a 'file allocation table' to control how long to keep images (in months). Images, scans, ECG trace...etc will occupy most of the data storage space in e-health records. Items such as handwritten 'to-do lists' or photographs might need less than one month storage, whereas other information might need to be stored for years. The volume of storage is managed to ensure that space is always available for new images.

Images will be PDF files converted to byte arrays and stored in the lowest fitting page blob.

The image index will be stored with the patients data and efficiently retrieved for viewing.

Other Details

The system can be used for any country or region. The initial set-up requires countries to be represented as 'qnnee' regions. This is a simple once-off task.

When the program runs page blobs for patients(P), providers/loaders(L), epidemiology(E) and the eight images blobs(I0 to I7) are automatically added as required.

Usage is similar to a standard medical practice paper records with the advantages of automation for storing images, digital prescriptions, telemedicine, population health management and appointment reminders.

Azure charges 0.5 cents (US) per gigabyte per month for data used. This application manages data efficiently making it practical to implement epidemiology and ehealth for any country at very low cost.

Epidemiology data is particularly interesting. This application would simplify recording and use minimal storage for huge information value. It would cost (globally) less than $5 a month!