Chapter 4. Deployment Strategies

DHIS 2 is a network enabled application and can be accessed over the Internet, a local intranet and as a locally installed system. The deployment alternatives for DHIS 2 are in this chapter defined as i) offline deployment ii) online deployment and iii) hybrid deployment. The meaning and differences will be discussed in the following sections.

4.1. Offline Deployment

An offline deployment implies that multiple standalone offline instances are installed for end users, typically at the district level. The system is maintained primarily by the end users/district health officers who enters data and generate reports from the system running on their local server. The system will also typically be maintained by a national super-user team who pay regular visits to the district deployments. Data is moved upwards in the hierarchy by the end users producing data exchange files which are sent electronically by email or physically by mail or personal travel. (Note that the brief Internet connectivity required for sending emails does not qualify for being defined as online). This style of deployment has the obvious benefit that it works when appropriate Internet connectivity is not available. On the other side there are significant challenges with this style which are described in the following section.

- Hardware: Running stand-alone systems requires advanced hardware in terms of servers and reliable power supply to be installed, usually at district level, all over the country. This requires appropriate funding for procurement and plan for long-term maintenance.
- Software platform: Local installs implies a significant need for maintenance. From experience, the biggest challenge is viruses and other malware which tend to infect local installations in the long-run. The main reason is that end users utilize memory sticks for transporting data exchange files and documents between private computers, other workstations and the system running the application. Keeping anti-virus software and operating system patches up to date in an offline environment are challenging and bad practises in terms of security are often adopted by end users. The preferred way to overcome this issue is to run a dedicated server for the application where no memory sticks are allowed and use an Linux based operating system which is not as prone for virus infections as MS Windows.
- Software application: Being able to distribute new functionality and bug-fixes to the health information software to users are essential for maintenance and improvement of the system. Relying on the end users to perform software upgrades requires extensive training and a high level of competence on their side as upgrading software applications might a technically challenging task. Relying on a national super-user team to maintain the software implies a lot of travelling.
- Database maintenance: A prerequisite for an efficient system is that all users enter data with a standardized meta-data set (data elements, forms etc). As with the previous point about software upgrades, distribution of changes to the meta-data set to numerous offline installations requires end user competence if the updates are sent electronically or a well-organized super-user team. Failure to keep the meta-data set synchronized will lead to loss of ability to move data from the districts and/or an inconsistent national database since the data entered for instance at the district level will not be compatible with the data at the national level.

4.2. Online deployment

An online deployment implies that a single instance of the application is set up on a server connected to the Internet. All users (clients) connect to the online central server over the Internet using a web browser. This style of deployment currently benefits from the huge investments in and expansions of mobile networks in developing countries. This makes it possible to access online servers in even the most rural areas using mobile Internet modems (also referred to as *dongles*).

This online deployment style has huge positive implications for the implementation process and application maintenance compared to the traditional offline standalone style:

- Hardware: Hardware requirements on the end-user side are limited to a reasonably modern computer/laptop and Internet connectivity through a fixed line or a mobile modem. There is no need for a specialized server, any Internet enabled computer will be sufficient.

- Software platform: The end users only need a web browser to connect to the online server. All popular operating systems today are shipped with a web browser and there is no special requirement on what type or version. This means that if severe problems such as virus infections or software corruption occur one can always resort to re-formatting and installing the computer operating system or obtain a new computer/laptop. The user can continue with data entry where it was left and no data will be lost.
- Software application: The central server deployment style means that the application can be upgraded and maintained in a centralized fashion. When new versions of the applications are released with new features and bug-fixes it can be deployed to the single online server. All changes will then be reflected on the client side the next time end users connect over the Internet. This obviously has a huge positive impact for the process of improving the system as new features can be distributed to users immediately, all users will be accessing the same application version, and bugs and issues can be sorted out and deployed on-the-fly.
- Database maintenance: Similar to the previous point, changes to the meta-data can be done on the online server in a centralized fashion and will automatically propagate to all clients next time they connect to the server. This effectively removes the vast issues related to maintaining an upgraded and standardized meta-data set related to the traditional offline deployment style. It is extremely convenient for instance during the initial database development phase and during the annual database revision processes as end users will be accessing a consistent and standardized database even when changes occur frequently.

This approach might be problematic in cases where Internet connectivity is volatile or missing in long periods of time. DHIS 2 however has certain features which requires Internet connectivity to be available only only part of the time for the system to work properly, such as the MyDatamart tool presented in a separate chapter in this guide.

4.3. Hybrid deployment

From the discussion so far one realizes that the online deployment style is favourable over the offline style but requires decent Internet connectivity where it will be used. It is important to notice that the mentioned styles can co-exist in a common deployment. It is perfectly feasible to have online as well as offline deployments within a single country. The general rule would be that districts and facilities should access the system online over the Internet where sufficient Internet connectivity exist, and offline systems should be deployed to districts where this is not the case.

Defining decent Internet connectivity precisely is hard but as a rule of thumb the download speed should be minimum 10 Kbyte/second and accessibility should be minimum 70% of the time.

In this regard mobile Internet modems which can be connected to a computer or laptop and access the mobile network is an extremely capable and feasible solution. Mobile Internet coverage is increasing rapidly all over the world, often provide excellent connectivity at low prices and is a great alternative to to local networks and poorly maintained fixed Internet lines. Getting in contact with national mobile network companies regarding post-paid subscriptions and potential large-order benefits can be a wort-while effort. The network coverage for each network operator in the relevant country should be investigated when deciding which deployment approach to opt for as it might differ and cover different parts of the country.

4.4. Server hosting

The online deployment approach raises the question of where and how to host the server which will run the DHIS 2 application. Typically there are several options:

1. Internal hosting within the Ministry of Health
2. Hosting within a government data centre
3. Hosting through an external hosting company

The main reason for choosing the first option is often political motivation for having “physical ownership” of the database. This is perceived as important by many in order to “own” and control the data. There is also a wish to build local capacity for server administration related to sustainability of the project. This is often a donor-driven initiatives as it is perceived as a concrete and helpful mission.

Regarding the second option, some places a government data centre is constructed with a view to promoting and improving the use and accessibility of public data. Another reason is that a proliferation of internal server environments is very resource demanding and it is more effective to establish centralized infrastructure and capacity.

Regarding external hosting there is lately a move towards outsourcing the operation and administration of computer resources to an external provider, where those resources are accessed over the network, popularly referred to as “cloud computing” or “software as a service”. Those resources are typically accessed over the Internet using a web browser.

The primary goal for an online server deployment is provide long-term stable and high-performance accessibility to the intended services. When deciding which option to choose for server environment there are many aspects to consider:

1. Human capacity for server administration and operation. There must be human resources with general skills in server administration and in the specific technologies used for the application providing the services. Examples of such technologies are web servers and database management platforms.
2. Reliable solutions for automated backups, including local off-server and remote backup.
3. Stable connectivity and high network bandwidth for traffic to and from the server.
4. Stable power supply including a backup solution.
5. Secure environment for the physical server regarding issues such as access, theft and fire.
6. Presence of a disaster recovery plan. This plan must contain a realistic strategy for making sure that the service will be only suffering short down-times in the events of hardware failures, network downtime and more.
7. Feasible, powerful and robust hardware.

All of these aspects must be covered in order to create an appropriate hosting environment. The hardware requirement is deliberately put last since there is a clear tendency to give it too much attention.

Looking back at the three main hosting options, experience from implementation missions in developing countries suggests that all of the hosting aspects are rarely present in option one and two at a feasible level. Reaching an acceptable level in all these aspects is challenging in terms of both human resources and money, especially when compared to the cost of option three. It has the benefit that is accommodates the mentioned political aspects and building local capacity for server administration, on the other hand can this be provided for in alternative ways.

Option three - external hosting - has the benefit that it supports all of the mentioned hosting aspects at a very affordable price. Several hosting providers - of virtual servers or software as a service - offer reliable services for running most kinds of applications. Example of such providers are Linode and Amazon Web Services. Administration of such servers happens over a network connection, which most often anyway is the case with local server administration. The physical location of the server in this case becomes irrelevant as that such providers offer services in most parts of the world. This solution is increasingly becoming the standard solution for hosting of application services. The aspect of building local capacity for server administration is compatible with this option since a local ICT team can be tasked with maintaining the externally hosted server.

An approach for combining the benefits of external hosting with the need for local hosting and physical ownership is to use an external hosting provider for the primary transactional system, while mirroring this server to a locally hosted non-critical server which is used for read-only purposes such as data analysis and accessed over the intranet.