Available online at www.fooddynamics.org

Int. J. Food System Dynamics 5 (4), 2014, 190-195

INTERNATIONAL JOURNAL ON FOOD SYSTEM DYNAMICS

Mark Online, a Full Scale GIS-based Danish Farm Management Information System

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Received October 2014, accepted November 2014, available online December 2014

ABSTRACT

With its oceanic climate with moderate summers and mild winters in combination with a highly organized infrastructure, farming has traditionally been very intensive in Denmark. The cultivated land constitutes 26,000 km² out of a total of 43,000 km². Most of the arable land is used for intensive plant production with a high level of mechanization and management practices. For more than three decades The Knowledge Centre for Agriculture (KCA) has developed and implemented ICT Farm Management Information Systems (FMIS) for planning and documentation of all aspects of crop production. Today, updated field specific information on field size, soil type, crops, varieties, soil tillage, sowing, fertilization, pesticide usage etc. is now hosted in the GIS-based FMIS, Mark Online covering more than 80% of the arable land. A centralized Microsoft SQL data base forms the core base for all the information. Based on a MS .NET framework a number of multi-tier client-server applications have been developed. Most of the desk top applications consist of relative thick clients based on Win forms, whereas HTML5 apps and Android/IOS native apps are used for the mobile platform. Data exchange between the clients and server are based on a web service layer using data compression to improve performance. Farmers are one of the two primary target groups. Local agricultural advisors working on behalf of farmers not having their own software is the other primary target group. Nonetheless, both groups are mainly focusing on field record planning, decision making and documentation. Data is transferred between the Mark Online system and the authorities by XML-based web services or ordinary file upload to official websites. The Open Geospatial Consortium's Web Feature Service (WFS) provides another interface allowing requests for geospatial features, which is used between Mark Online and external GIS.

Keywords. FMIS, field record keeping, client-server, data base, Denmark

* Jens Bligaard. "Mark Online, a full scale GIS-based Danish farm management information system". World Conference on Computers in Agriculture and Natural Resources, University of Costa Rica, San Jose Costa Rica, July 27th-30th, 2014. http://CIGRProceedings.org

1 Introduction

Since the introduction of the first farmer owned cooperative in 1882 Denmark has been a country with an intensive and well organized farming structure. The oceanic climate with moderate summers and mild winters is ideal for most types of crop production. The average temperature varies from 0 °C in winter (January-February) to 16 °C in summer (July-August) and the average rainfall is app. 70 cm per year, almost evenly distributed over the year. The cultivated land constitutes 26,000 km² out of a total of 43,000 km². Most of the arable land is used for intensive plant production with a high level of mechanization and management practices. The main crop in Denmark is grain, mainly winter wheat, winter and spring sown barley, triticale and to a certain degree rye, covering more than 50 % of the total arable land. Fodder crops, mainly grass and maize for silage, amounts to a little more than 20 %, and the rest of the area is grown with seeds for sowing or industrial use, root crops or permanent grass fields used for livestock feeding (Agricultural Statistics, 2011). Although the number of individual farms is steadily decreasing year by year, the total production output has slightly increased due to improvements of the production methods. Danish farmers produce a total of 20 million slaughter hogs yearly whereas milk production amounts to 4.8 million ton from 575,000 dairy cows. Generally, two thirds of the Danish agricultural production is exported to more than 100 countries all over the world. Only half of the export goes to EU-countries. This means that Danish farmers are competing with farmers on the world market – especially with countries with much lower prices on land and man power. Furthermore, Denmark has since the mid-eighties had a number of limiting restrictions on fertilizer and pesticide use due to an increasing number of national rules and regulations to protect the environment. Hence, all relevant new technology must continuously be introduced in the production line as well as the production methods have to be improved continuously to stay competitive.

For more than three decades The Knowledge Centre for Agriculture (KCA) has developed and implemented ICT Farm Management Information Systems (FMIS) for DSS, planning, documentation and advising on all aspects of husbandry and crop production. Farmers are one of the two primary target groups for these systems. Local agricultural advisors working on behalf of farmers not having their own software is the other primary target group. Mark Online is the overall brand name for the FMIS for crop production developed by KCA.

2 System Description

Mark Online is based on a traditional client-server architecture that partitions the task or workloads between the servers and the distributed clients. The communication between the server and the clients is based on a service layer using data compression to improve the performance via the internet. The system requires ADSL or better by the end user to function acceptable.

2.1 Multi-tier application

Mark Online is a multi-tier client-server application, where the user interface, the business rules, and data storage and management functions are physically separated as independent modules (fig. 1). The graphical user interface or presentation layer is run by the farmers or advisors, typically on a client at a desk top pc. The business logic is handled by a centralized application server, and similar, the database is handled by a centralized Microsoft SQL database server placed at KCA. The database server is backed up on a daily basis, with the possibility to restore the entire database or only the data for an individual farm.

2.1 The clients

The desk top client is based on the MS.NET framework with the Click Once methodology delivered by Microsoft. This enables the user to install and run a Windows-based smart client application just by clicking a link in an ordinary web page. By using this deployment technology for new applications the user will automatically be presented for the latest version of the application since the application checks for newer versions and any updated files at startup. At the same time, the smart client technology captures the benefits of auto-update with the high performance and high productivity of a fat client.

Besides the above mentioned smart clients other applications also can approach the central database. A mobile web browser application, Mark Mobile, based on HTML5 also communicates with the business layer and the database through the service layer. Due to the used web browser technique this application is platform independent and could be used on all smart phones and tablets. Similar the GPS-based mobile app, LetFarm, communicates through a service layer. LetFarm is offered as an off line native IOS and Android app.

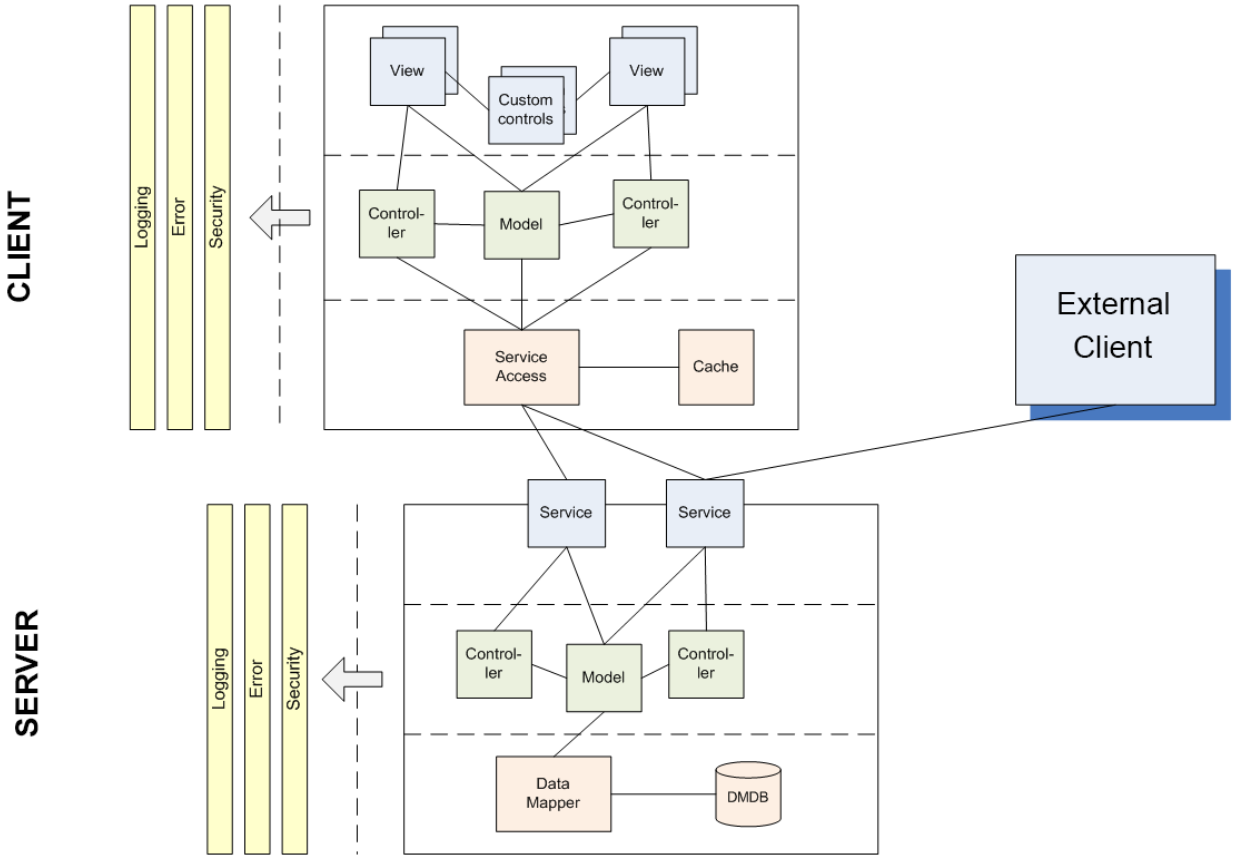

Figure 1. Illustration of the multi-tier architecture of Mark Online. DMDB is the central database.

3 System Usage

3.1 Mark Online

The Mark Online client is sold in four different versions Light, Basic, Plus and Premium. The Light version only contains the necessary functionality for the obligatory documentation of pesticide usage. In this version, the farmer can plan and register his pesticide treatments with date of treatment, pesticide, dosage and crop and field information. Since Mark Online is connected with the national pesticide database, www.middeldatabasen.dk, that contains all available data on all approved pesticides in Denmark, data input is validated continuously. This ensures that Mark Online is able to help the user to avoid errors in the planning or registration of pesticide use.

The Basic, Plus and Premium versions of Mark Online are full scale field record tools with additional functions for making smart management decisions. With these versions the farmer is able to manage fields, equipment, supplies, and personnel. These versions also contain the basic functionalities for budgeting and for calculating the economical results on a field or crop basis as well as a map viewer to show field polygons in a GIS on a background of aerial photos delivered by Google®. Furthermore, the Premium version contains all necessary functionality to ensure the fertilizer usage complies with the strict national environmental rules and regulations.

The two mobile versions of Mark Online, i.e. Mark Mobile and LetFarm, allow the farmer to collect basic registrations from the field. No matter which device is used, all data are stored in the centralized database, and hence immediately ready for use by all other clients.

Mark Online contains a DSS regarding irrigation management. When a field is set to be irrigated, Mark Online automatically imports real-time site specific weather data for precipitation (mm/day), daily mean temperature (°C) and the potential evaporation (mm/day) via a web service provided from the Danish Meteorological Institute. The weather data is used for a decision support model that based on the calculated crop growth stage, evapotranspiration and soil water balance, predicts the optimal timing for irrigation (Plauborg & Olesen, 1991).

Mark Online is also used for documentation purposes. Data is transferred between the Mark Online system and the authorities, e.g. the Ministry of Food, Agriculture and Fisheries by XML-based web services or ordinary file upload to official websites. In all cases this is implemented as push-functions requiring user action since it is extremely important for the farmer, that the authorities – or anyone else - do not have unauthorized access to his data. As a consequence of this, Mark Online contains a legislation function, which ensures that only the farmer can decide who should be able to access his data.

The Open Geospatial Consortium's Web Feature Service (WFS) provides another interface allowing requests for geospatial features, which is used between Mark Online and external GIS.

3.2 Data types

The database holds both tabular and spatial data. On a farm level the database contains information on all animal husbandry, e.g. number, weight, housing type and production data. Regarding storages, the system contains detailed information on amounts of manure and nitrogen content, as well as information on produced fodder. On a field level, the system keeps track of each individual field polygon, e.g. its size and geographical location, the specific crop, variety, soil type and soil analyses, soil tillage, seeding operations, fertilization, pesticide treatments, and yield information.

3.3 Market penetration

Mark Online is by far the most dominant FMIS in Denmark. Individual farmers use the system on more than 1.0 million ha in Demark. Apart from this the agricultural advisors use Mark Online for planning and documentation purposes for farmers who either do not have any software themselves or farmers who use the system in close collaboration with their local agricultural advisor. All in all more than 80% of the total arable land is today planned by Mark Online with an almost evenly geographical distribution throughout the country (fig. 2).

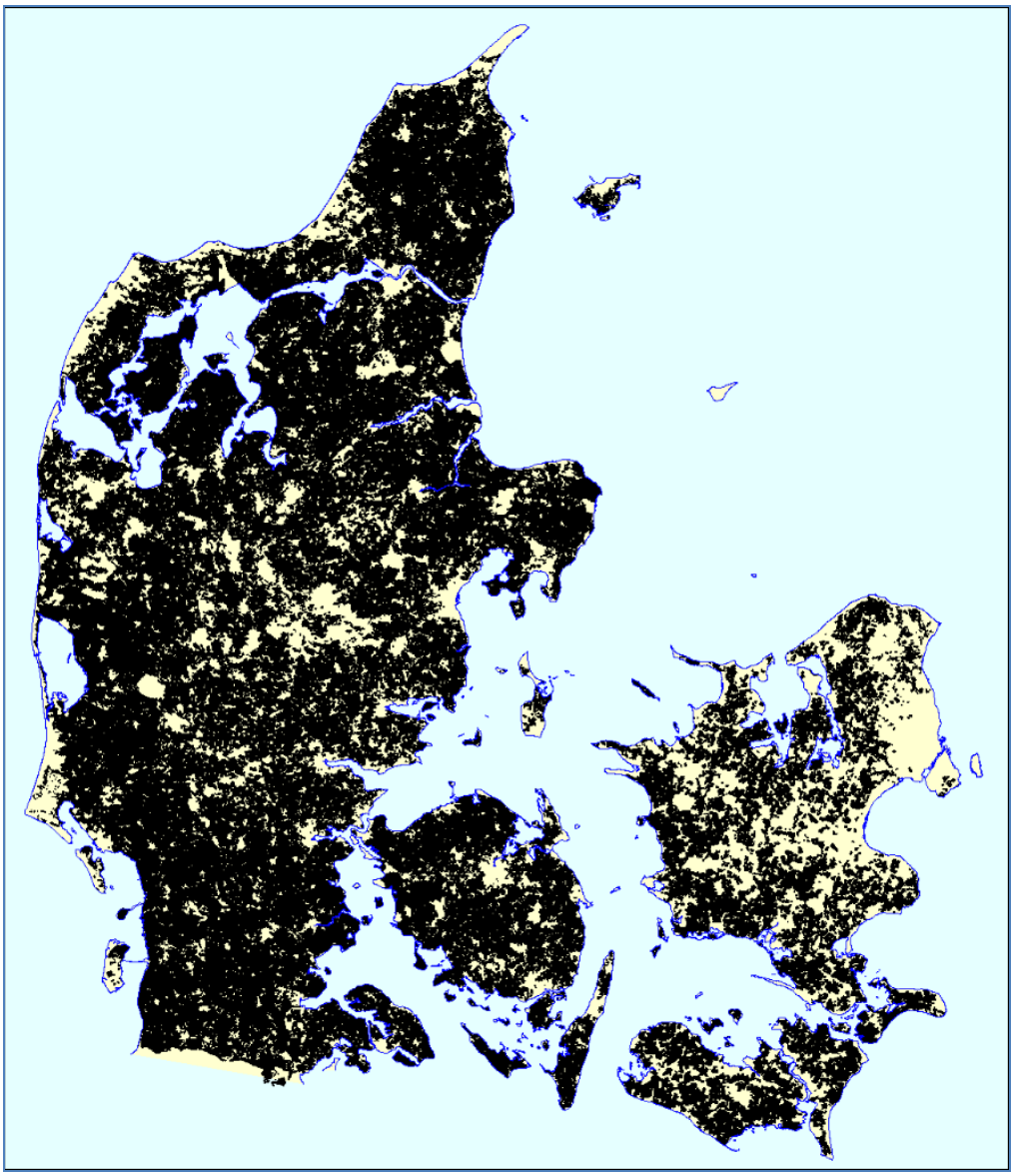

Figure 2. Map of Denmark shown with a black dot for each individual field with data in the Mark Online database.

4 Perspectives and Conclusions

The demand for advanced farm management and decision support tools will increase drastically in the future. Especially, since the world is facing an ever increasing demand for food on a global scale. Intelligent use of all available information will be the key to better management decisions and higher yields. Producers of farming equipment are going to embed sensors in all new products in the coming years, resulting in a high number of agricultural data platforms offering vast amounts of data ready for practical data mining, precision farming and decision making e.g. benchmarking, variable rate application of fertilizers and pesticides, variable soil tillage based on soil maps, weather data and yield data, logistic route planning and optimized harvest operations.

The Mark Online system is designed to meet the needs of the farmers today and tomorrow. The internet based client-server concept with a centralized database ensures, that the decisions taken by the farmer, his employees, his advisor or other partners always use the same updated information – no matter whether this is done by a classic desk top application or a mobile app from the field. Moreover, the extensive use of web services based on open standards has proven to be a flexible way to integrate different applications and data from different platforms. In this context standardization is with no doubt the key to interconnectivity and data integration. It is therefore of the utmost importance that all new data platforms and FMIS use standardized interfaces and data formats in order to increase the productivity of the farmers in the future.

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