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ARMS: An automated resource management system for British Telecommunications plc

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Abstract

Accurate demand forecasting combined with resource planning is critical to a company's performance and profitability. This paper describes ARMS (automated resource management system), an integrated system developed for the customer service operations of British Telecommunications plc to help with the operational/tactical planning and deployment of the company's 20,000-strong field engineer workforce. ARMS integrates a forecasting tool with a resource planning tool and a resource balancing tool providing an end-to-end automated resource management solution for the organisation. OR techniques are used throughout the system, including ARIMA for forecasting, constraint satisfaction for problem modelling, heuristic search for problem solving thus demonstrating the value and relevance of OR in solving today's business problems.

Keywords: Telecommunications; Manpower planning; Forecasting; Heuristics; Multi-agent systems

1. Introduction

The need for automating resource management, herein referred to as RM, is well recognised and has been the subject of considerable research and development [21,3,5]. The case for automating RM is motivated by the drive to maximise profits, improve quality of service (QoS) and reduce costs. There are three basic tenets of resource management:

(i) *Forecasting*: The ability to forecast the demand of work.
(ii) *Analysis*: The ability to analyse resource and job profiles and identify either over or under resource utilisation. A resource profile refers to a particular collection of location (i.e. area), skill and availability (i.e. time) data.

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A job profile on the other hand refers to attributes of the job such as priority, start and end dates, job type and so on. Analysis comprises resource planning and scheduling. Resource planning involves profiling where resource profiles are adapted with a view to matching configuration of skills, availability and locations of the resources to the skills, timing and locations of the jobs making up a particular workload. Resource scheduling is concerned with assigning resources to actual jobs and identifying explicit execution times for those jobs. Resource planning is an essential pre-cursor to successful resource scheduling.

(iii) *Execution*: The ability to execute the output of the analysis—in terms of dispatching jobs to resources, making requests for extra resources in case of over resource utilisation.

Successful automation of RM requires that the aforementioned tenets be fully automated. Indeed operations research and artificial intelligence methods [20,15,2,23] have been employed to automate some aspects of RM. For example the auto-regressive integrated moving-average i.e. ARIMA model [4,7] has been successfully employed in forecasting jobs [21,11]. Constraint satisfaction [15,2] and heuristic search methods [16,20] have been applied to resource allocation problems.

In this paper we describe work we have done in developing an automated resource management system called ARMS, to automate the planning and deployment of field engineers within the customer service division of British Telecommunications plc (BT). BT is the UK's largest fixed telecommunication services company with over 20,000 field service engineers undertaking repair or provision tasks for the company's customers on a daily basis and across the UK. BT's field engineers are allocated jobs via an information system known as Work Manager [13,16]. In order for BT to best serve its customers, resource managers within the organisation have to ascertain how best to plan and deploy the company's field engineering workforce on an operational/tactical basis (i.e. for the following day and up to 14 days ahead).

Generating the plans involves:

- Forecasting demand for several activity types (e.g. provision, repair, maintenance work).
- Planning the volumes, skills and geographical locations of engineers required in order to service that demand in the next 7 up to 14 days.
- Deploying field engineers for tomorrow in the best possible manner so that incoming and existing work can be optimally scheduled by the company's automated workforce scheduling system [13,16].

Each resource manager is typically in charge of around 150 engineers and he/she has certain degree of control in deciding the planning and deployment of the workforce. For example, the following possibilities can be considered and decided upon:

- Engineers are multi-skilled and they can perform several tasks requiring different competencies and capabilities. There are currently nine different ''skills'' defined for the purposes of RM with each engineer having one or more of these skills depending on past training and/or experience. The resource manager can focus specific engineers to work on activities of a particular skill or type.
- Engineers have the flexibility to move around between relatively small geographical areas called ''patches''. A customer service team (CST) usually is responsible for several patches and the resource manager has the responsibility to resource each patch adequately by moving engineers from neighbouring patches or by altering their working pattern to be explained next.
- Engineers have different working patterns. They can work full day or half a day. They may also be available to come and work on overtime on voluntary basis. Furthermore, they have several business related absences or meetings scheduled which, if necessary, could be cancelled to increase availability in certain geographical areas or on specific dates.

Considering all these factors, generating a resource plan means forecasting demand in terms