

■ White Papers

Business Modelling
of Radio Systems

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January 2008

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Business Modelling of Radio Systems

Overview:

It is essential that network operator organisations allow their accountants to appraise future wireless network developments. This appraisal must determine the cost of deployment and the revenue this deployment will bring. In addition accountants should use this data against time to determine the financial rate of return using accepted investment appraisal metrics.

This paper illustrates a combined modelling approach that models the proposed network in a 'real-life' form to yield accurate financial outputs. It shows how to combine software applications in a seamless fashion using the technical modelling data in a financial model to illustrate the effect on network viability from any aspect of user behaviour. By joining the world of wireless engineering with finance, it represents a revolutionary new approach to what has previously been a rather crude process where cells are represented by hexagons assuming perfect coverage and perfect traffic handling. The system provides a complete solution for wireless network appraisal.

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Introduction

Wireless networks require a considerable investment commitment over a period of several years. Any financier wishing to invest in a wireless network needs to know how many customers will be captured, how much traffic they will generate and projected revenues. On the other hand he needs to know the total cost of deploying a network capable of servicing these customers. This cost is dependent on the number of base stations or sites needed and, in turn, the cost of equipment at those sites. The revenue and costs are a balance and are substantially a variable within the network operator's control. It is the network operator's choice as to what market he attacks and what services he offers.

In making this choice, the financier must make an investment appraisal. This appraisal should demonstrate the benefits of investing in the wireless network as opposed to an alternative venture or even in the bank. Commonly this is done using indices such as the Accounting Rate of Return or the Discounted Payback Period. Such indices permit the income versus expenditure equation to be balanced considering the cost of money and the time value of money.

This paper covers three areas: the development of a proposed wireless network plan encapsulating the costs, the determination of the services demanded from a given customer base from which revenue is derived and the balance of cost and revenue to generate financial statements from which investment appraisals can be made.

Financiers are seldom faced with a single option. There are many approaches to network deployment, each aiming to address the market in a particular way in order to maximise investor benefit. Historically this has been proven. For example, in the UK, Vodafone led the market with one competitive advantage; network coverage. Even

in the mountains of Scotland, customers could always get service. However, early Vodafone's competitors such as Orange only provided a thin coverage across Great Britain and while users could get service it was often erratic. One-to-One on the other hand opted for intensive coverage of London providing subscribers a high quality service across the capital but nowhere else. Both illustrated very different business plans with differing return on investment profiles. Both had the same end goal: to compete with Vodafone; they simply chose different starting points from which to achieve it.

This historical example shows that appraising a wireless investment demands that many options be considered. The plans will all be significantly different, balancing coverage, services and markets. All require to be appraised on a 'level playing field', against the same criteria. This paper addresses this issue by illustrating how a wireless network planning tool (ATDI's ICS Telecom) can be interfaced to an accounting package (Sage Winforcast) and how, with a little additional processing, the combination can be used to generate all the appraisal metrics needed.

The balance between revenue and costs will have specific sensitivity. Consideration must be given to a host of different scenarios. For example, changing services offered will demand more equipment- but how much more? Changing from fixed service to nomadic and then to mobile will need dramatically more base stations - but how many more? In addition, understanding the sensitivities of the investment to change can highlight potential risks. If customer take up is much lower than expected, how can the deployment be slowed to maintain return on investment? Alternatively, if the take up is greater, how will the resulting reductions in Quality of Service affect revenue?

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Business Model Requirements

The business model is a machine. It takes in a set of engineering criteria, cost and revenue data, processes this data and gives a set of investment appraisal data as output. Once set up, the machine can be run as many times as needed with different inputs, different transfer function and provide different outputs.

In order to build the business model we require:

- A project aim that outlines what the business wants to achieve including a project plan showing actions (equipment deployment and subscriber connection) against time
- A project design determining the technical solution to serve the subscribers against a given performance
- A subscriber base to be served by the project design
- Capital costs of the network realised in the project design
- Revenue costs of the network realised in the project design
- Revenue generated by the subscriber base

The project definition is a simple statement of:

- What services are required?
- Where they are required?
- Who requires them and what are the subscriber's user patterns?
- How quickly they need to be implemented?

This project definition provides the main boundaries for the model and should be kept short and to the point. It is critical that significant thought is given as errors at such an early stage can cause the wrong network to be designed and the wrong solution to be generated. It can of course be developed iteratively using the business model to probe options until the optimal solution is reached.

The project design is developed using a radio planning tool like ICS Telecom against design objectives to connect the subscriber base to associated infrastructure in accordance with the project aim. This in turn will meet the user requirements and therefore generate the expected revenues.

The capital costs include the purchase cost of the items identified in the project design as well as the manpower required to roll out the network. Later in the investment appraisal this will include the cost of capital.

The revenue is the predicted income generated as various sections of the network go live and subscribers load the network with traffic for which they are charged a tariff. This factor is dependent on sales or marketing campaigns and therefore is a function of the plan showing action against time.

Modelling tools

To undertake this business modelling, five software packages need to be combined. These software packages are:

- Microsoft Word
- Microsoft Project
- ATDI ICS Telecom
- Microsoft Excel
- Sage Winforecast

Word is used for the initial project definition and any further documentation required. Microsoft Project is used to schedule the project activities and the manpower needed to implement the network. ICS Telecom is used to design the radio network, placing base stations and other infrastructure to meet the network objectives. As will be seen later the ability of ICS Telecom to produce a detailed network plan and evaluate trade-off has significant effects on the cost of the project. Microsoft Excel is used for storing tables and data from Microsoft project and ICS Telecom and undertaking some of the simple dimensioning calculations. Winforecast picks up all its information from the Excel tables and produces the financial statements from cost to revenue forecasts. Excel is also used for computing the metrics of investment appraisal from the data produced by Winforecast. These software applications work together in a process to go from business aims to appraisal metrics.

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Information processes

To undertake the overall modelling, information needs to be passed between the five software packages. The diagram

below illustrates the information flow between each of the information activities in the overall process.

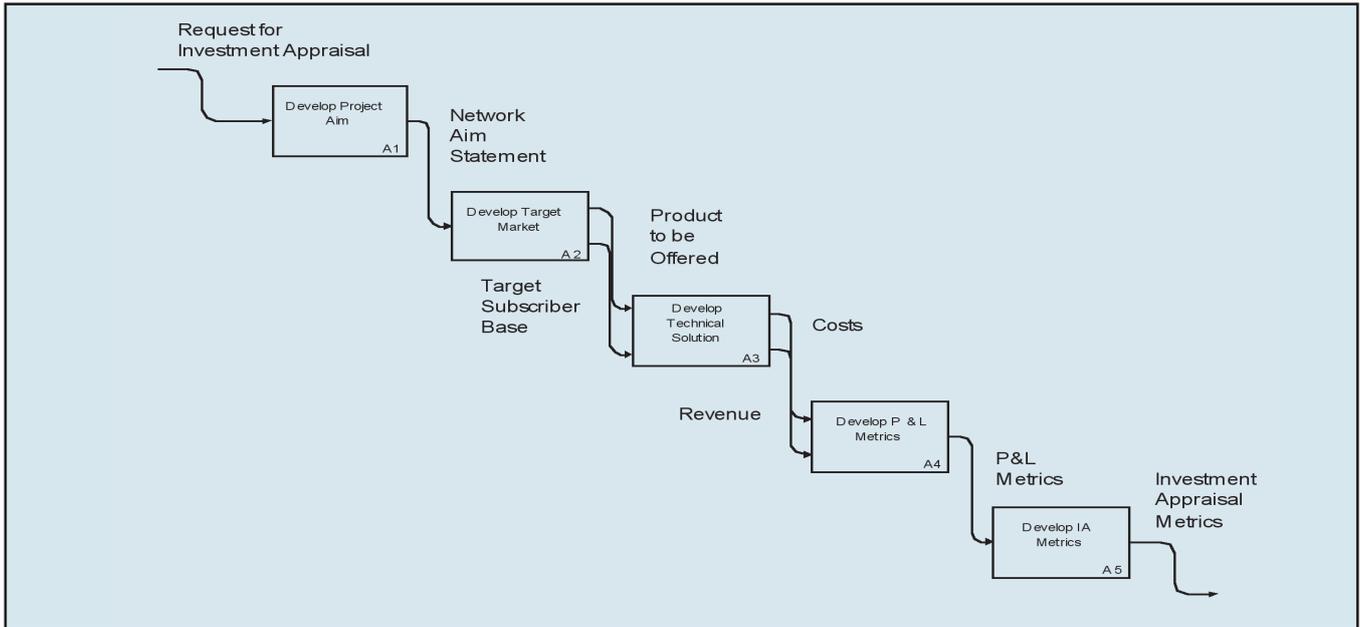


Figure 1 Information flow between the various activities

In all the cases above the data is flowing towards Winforecast, used to develop the P&L metrics in A4. The technical solution is developed in activity A3 in ICS Telecom. The project aim is developed in A1 using MS Project to express project outcomes against time. ATDI have developed an interfacing Excel spreadsheet that takes information from MS Project and directly from standard ICS Telecom outputs and arranges the information automatically into a form from which Winforecast can extract the data it requires. This allows sensitivities such as deployment strategy and time scales to be examined without extended manual intervention. Finally, the investment appraisal metrics are developed using Excel in A5.

Why ICS Telecom?

The above diagram shows the four software applications arranged as activities, each carrying out a function in the overall process. The network modelling tool is critical to the success of the investment appraisal process. In any network there are three interrelated aspects to be modelled: connectivity between nodes and subscribers, traffic flow between nodes and subscribers and interference that

degrades both connectivity and traffic carrying capability. Interference is in turn a consequence of available spectrum and frequency planning. Interdependence makes modelling non-trivial. Modelling acts to balance this interdependence while achieving the project aim. ICS Telecom permits the three aspects to be exercised and appropriate trade-offs made in an environment that is a good representation of reality.

In business modelling, tools such as ATDI's ICS Telecom are unfortunately often replaced by 'coffee cup' circles where algorithms that express the connectivity available between network nodes and network subscribers are replaced by simplistic representations of reality such as circles or hexagons. These impact on the accuracy of the design. Reduced reality in modelling connectivity ultimately effects the reality of traffic and these combined make any assessment of interference almost meaningless. The result is the production of crude metrics for investment appraisal. The following example amplifies this argument using connectivity alone. It illustrates that for this aspect, a good representation of reality, such as is provided by ICS Telecom, and is essential.

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Traditional, simplistic business models for radio networks tend to make assumptions on the coverage achieved from a typical base station in the given environment. Take for instance a WiMAX mobile network in London within the M25 where a typical cell radius of 1.5km might be used. Using hexagons, this would give a cell count of around 400. This is shown below. London is divided into five regions shown by the coloured areas.

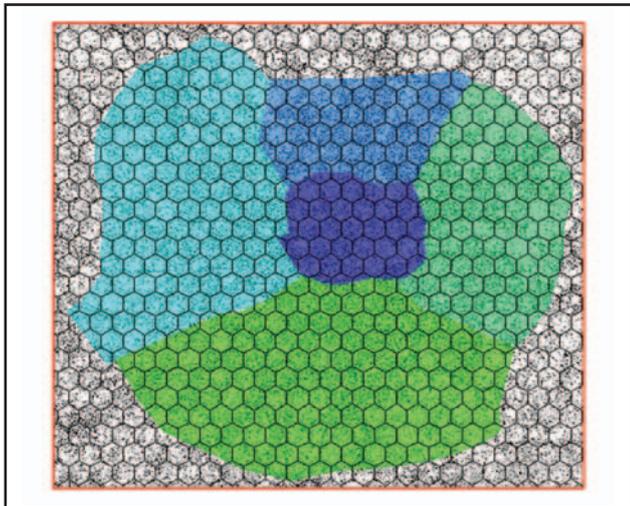


Figure 2 Modelling areas with service supplied by constant cell-size base stations

Since cell size is a function of the degree of urbanisation, one might be a little more sophisticated and use typical cell sizes in the different environments, ie, ranging from 2.5km in rural environment to less than 1km in heavy urban environments. This gives a cell count of around 300. Variations on this theme are possible but the model is still simplistic.

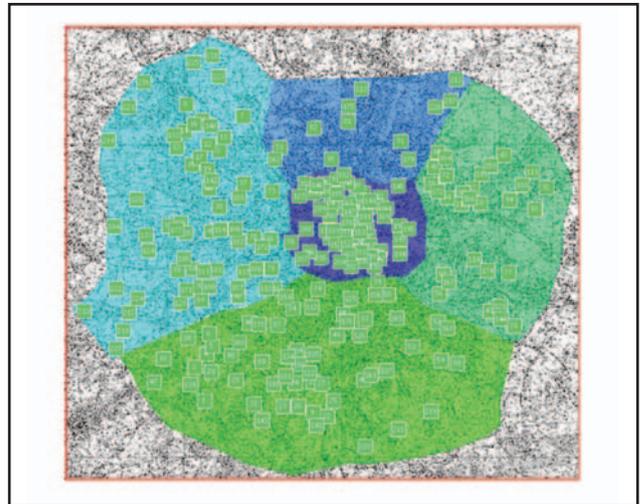


Figure 3 Base station generated by ICS Telecom to match modelled customers

If, on the other hand, ICS Telecom is used and a good model of the real terrain and urbanisation is employed to permit accurate computation of propagation loss, the 'cell' count drops to around 250 cells.

Note that the system is in all cases assumed to be limited by basic electrical noise and not constrained by any effects of traffic load or interference.

This comparison shows that the difference in the approach to modelling the network can lead to large differences in equipment, manpower and sites. If the constant cell size model had been used for the investment appraisal, the cost of the project could have doubled and hence the likelihood of it being viable, somewhat reduced. This example used connectivity modelling alone. As noted above, connectivity, traffic flow and interference are all interconnected. To undertake comprehensive three-aspect modelling requires extensive development of method within applications such as Excel. This effectively duplicates modelling functions such as traffic flow, capacity modelling, frequency assignment, checking regulatory compliance and the like, while using dynamic throughput in line with dynamic modulation schemes and sub-channelisation varying by time and up-link/down-link direction. Since modelling tools such as ICS Telecom exist as off the shelf software solutions, replication in Excel would be a huge and an unjustifiable task.

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Data in business modelling

The various processes and the tools used to complete them have been set out. In Figure 1, a number of data were shown as inputs and outputs to the various activities. Each is made up of a number of sub-sets of data and each is essential in some form in order to generate the final data – the investment appraisal metrics. The data needed from activity A1 is a statement of the aim of the project and its resulting network or networks. This is a quantitative statement giving the rationale behind the network and from this, what the investors can expect to realise in return for their interest in the project. Data input to and coming from the other activities are all quantitative and defined in terms of time, space and product, setting out what product will be deployed, when and where to yield what outcome. These data are as follows:

- Product(s) - setting out what service is to be offered to the customer base
- Timescales showing the phases of roll-out
- Infrastructure needed to deliver the product(s)
- Unit manpower costs to implement the network(s)
- Unit infrastructure costs
- Target subscriber base set out in time, space and service demand
- Forecast revenue specified by subscriber, time, space and service
- Sales & Marketing
- Information on the cost of money over the life of the network

The time scales are detailed in MS Project and determine when various activities will occur. This data is exported to an Excel interface spreadsheet and used to determine the manpower requirements and labour costs for each stage of the project. An example of this can be seen in labour for the above cell count argument. In this, 250 cells are required to serve the target market. From the project plan we have 9 months to install and commission these cells. Given that the install time is 6 man days per cell, this gives 1500 man-days to install the network. Since we have 9 months to undertake this work this means we will need around 8 installation teams to complete the work on time. Given this information along with installation team unit costs, the cost of the installation manpower can be determined.

Since this data is transferred seamlessly from MS Project to MS Excel, a change in the project plan will ripple through the modelling system and the affects on the business plan can be seen immediately.

A diverse range of equipment information is required in order to dimension the infrastructure ranging from the technical parameters used to calculate the link budgets

to the equipment configurations that lead to particular network topology (and hence traffic carrying ability) through to the time needed to install and commission. Unit costs are required for capital equipment such as base stations, power supplies, antennas, masts, towers and transmission equipment and also for manpower in installations, operations, sales and marketing. Again this information is collated in the Excel spreadsheet so that changes in costs can be accounted for easily.

The target market expressed as the total available subscribers and subscriber take-up can both be linked directly to effort expended in sales and marketing: more effort in sales captures more subscribers in a shorter time. In turn the payback period reduces, making the venture more attractive. Again, data is populated in the interface excel spreadsheet to allow modelling of different subscriber adoption rates and their revenues. To accurately undertake the business model, financial information such as interest rates, payment times, credit times and discount rates are required. Most of these values are constants assumed from forecast and used in scenario modelling to model future macro-economic events. This data can also be entered into the interface Excel spreadsheet so that the effect of changes in the various rates can be assessed.

The process used for business modelling

The various activities form a holistic process. The following sections describe how various data are used to eventually yield the investment appraisal metrics.

The project

A project plan needs to be developed to set out the times when various activities occur. This allows the model to automatically use unit manpower costs for activities such as surveying, installation and planning. If the modelling process determines that 100 base stations need to be installed in 100 working days and one installation team takes 2 days to install one base station, 2 installation teams will be required. This type of cost build-up ripples through the process making changes and scenario modelling simple. Under user control, other activities such as project setup, project planning, site acquisition, site planning and equipment installation and commissioning through to network in-traffic can be costed. Ongoing operations and maintenance can also be included in the project plan and their costs included in ongoing revenue costs. An example project plan is shown overleaf with some typical activities.

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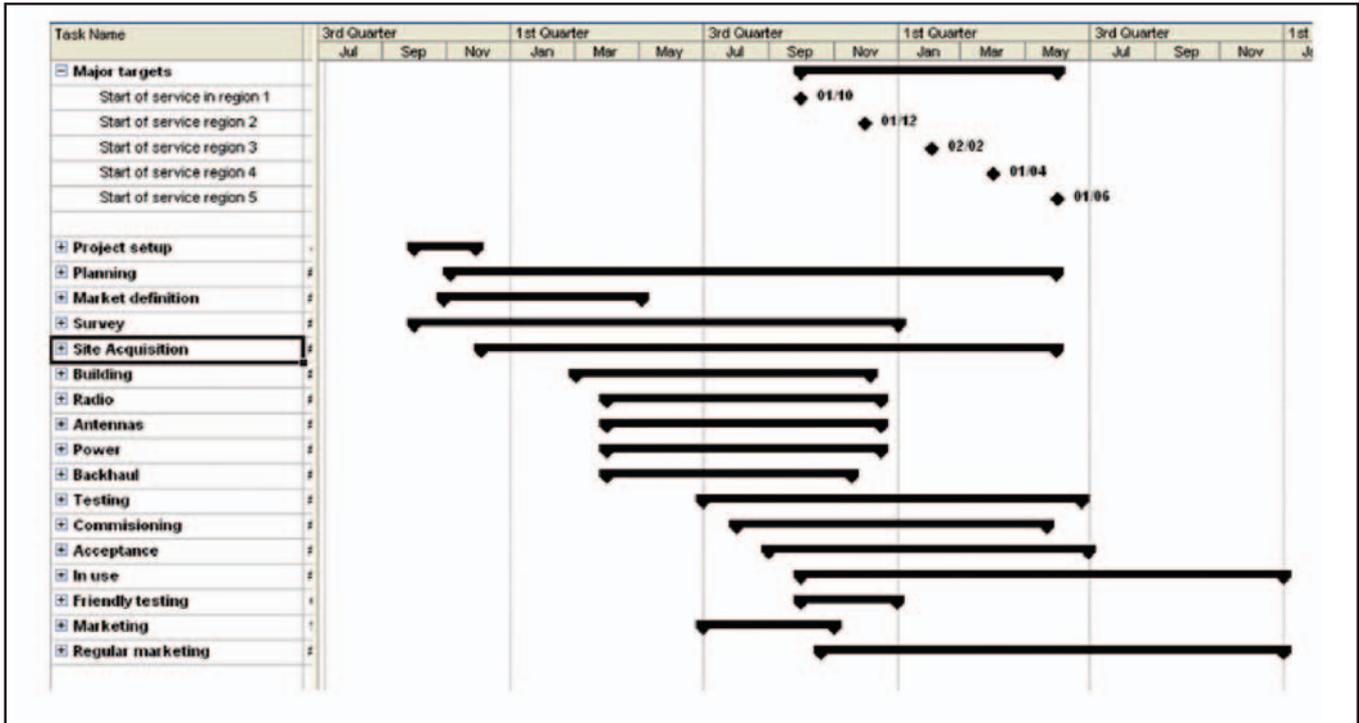


Figure 4 Outline project plan giving time scales

This plan is then exported from MS Project to the Excel spreadsheet where it is combined with other data and passed on to Winforecast.

The network design

The first step in developing the network plan is to determine the environment in which the network is going to be planned. The planning activity makes use of a model of this environment. This model uses a digital terrain model (giving ground heights at a raster of points on the ground) combined with some statement of urbanisation and vegetation (either as precise building and tree heights and locations or as a general statement of urbanisation described as a 'clutter' model). The exact nature of the environmental model needed for different technologies and topologies is beyond the scope of this paper. By way of example, if we are modelling a mobile WiMAX system with both indoor and outdoor coverage requirements, a high resolution digital terrain map would be required with either a matching detailed clutter definition or a building layer.

The following figure shows an example of a clutter model relating location to urbanisation. The centre of the city is clearly seen in blue.

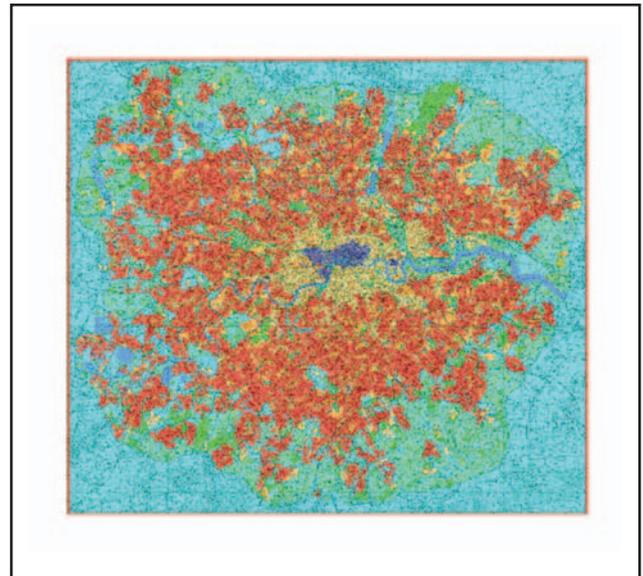


Figure 5 Map of London bounded by the M25 motorway showing clutter

