White Paper

Rail Crew Scheduling, Rostering and Management

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OVERVIEW

This paper will explore the complex process of train crew management and present an approach to streamlining the process and optimizing the outcomes.

Crew Management. Scheduling, rostering and on-the-day management of train crew are some of the many complex tasks that a rail organization must perform. Given that most rail companies are facing an increasingly competitive environment, it is critical that they have excellent systems and processes for operating and managing all aspects of their operations. By optimizing and streamlining their crew scheduling, rostering and day-of-operation management, rail companies can successfully target a major component of their rail operations. Opcom has developed an optimization approach to crew planning and has incorporated this into deployable software (OPCrew) which can be used to realize increased operational efficiency.

OPCrew is a unique system for automatic, optimized rail crew scheduling and rostering. It enables significant cost savings, reduced crew planning cycle times, more equitable crew rostering and comprehensive management information. The system has been specifically developed for the rail industry and is suitable for both urban and long-distance rail crew scheduling.

Benefits

• In comparison to traditional methods, the cycle time for producing a full set of data for new timetables is drastically reduced.

• The crew schedules and rosters produced can result in significant cost savings. As crew costs are a significant part of the total operator costs, the saving can be large. Savings in crew costs of over 5% have been achieved.

• The crew rosters produced are significantly more equitable.

• Accurate reports on key performance indicators are given by the system.

• The reduced cycle time allows a range of ‘What if?’ scenarios to be examined including the:
  o Crewing implications of proposed timetable changes
  o Effect on scheduling costs of a change to the proportion of different shift types
  o Effect of changes to award rules (useful as a tool in enterprise bargaining)
  o Optimal depot staffing levels
  o Economics of new depot facilities

• Day-of-operation crew management is more effective.
# TABLE OF CONTENTS

**1 INTRODUCTION**

1.1 The Issue ......................................................................................... 3

1.2 The Proposal .................................................................................. 3

**2 THE CREW MANAGEMENT PROCESS**

2.1 Crew Scheduling ........................................................................... 4

2.2 Crew Rostering ............................................................................. 5

2.3 Day-of-Operation Management ..................................................... 5

**3 AN OPTIMISATION APPROACH**

3.1 Schedule Optimisation ................................................................. 6

3.2 Roster Optimisation ..................................................................... 6

3.3 The Process .................................................................................. 7

3.4 Inputs to the Process ................................................................... 8

3.5 A Unique Approach .................................................................... 9

**4 AN OPTIMAL SYSTEM: OPCREW**

4.1 The OPCrew Navigator ............................................................... 11

4.2 The OPCrew Infrastructure Editor .............................................. 11

4.3 Timetable Management Subsystem (TMS) ................................. 12

4.4 Crew Scheduling Subsystem (CSS) .............................................. 12

4.5 Schedule Set Optimisation .......................................................... 13

4.6 Rostering Subsystem ................................................................ 14

4.7 Train Crew Assignment Subsystem (TCAS) ................................. 16

**5 THE CASE FOR DEPLOYMENT**

5.1 Benefits ....................................................................................... 18

5.2 Why Opcom ............................................................................... 19

**6 GLOSSARY** .................................................................................. 20
1 INTRODUCTION

1.1 The Issue

Creating the train crew schedules and rosters that are required to support the operation of train workings can be a labor intensive and complex task.

Some train operators have unwieldy non-integrated legacy systems for this task, include crew scheduling with train scheduling, or construct crew schedules and rosters manually. This makes it difficult to:

- React to frequent or short notice changes in the train timetable
- Analyze the impact of a range of operational scenarios on crew
- Construct optimized crew schedules and rosters
- Manage the range of changes presented on the day-of-operation.

Rail companies are facing increased competitive pressures due to ownership changes (eg privatization), the vertical disaggregation of traditional rail companies and the associated granting of open access to rail infrastructure and the movement of integrated logistics businesses with established clients into the rail sector. Therefore to remain competitive rail companies must ensure that they have excellent systems and processes for operating and managing their assets and operations.

1.2 The Proposal

As a result of the increasing requirement to be more competitive, rail companies must exploit and enhance their competitive advantage as rail specialists. They must have best-in-class rail operations and take steps to increase planning and operational efficiency.

Rail companies can target planning and operational efficiencies by optimizing and streamlining their crew scheduling, rostering and day-of-operation management. To help companies realize these efficiencies Opcom has developed an optimization approach to crew planning and has incorporated this into a deployable system called OPCrew.

The deployment of OPCrew allows a rail company to enhance the efficiency of its operations and provide the flexibility that is required to face the challenges of its business environment. OPCrew provides the ability to quickly produce efficient crew schedules and rosters, coupled with the capability to manage crew operations flexibly and accurately on the day-of-operation. Additionally, it provides the ability to examine a wide range of operational and crew scenarios and quantify their impact on operational and business performance.
2 THE CREW MANAGEMENT PROCESS

Crew scheduling, rostering and operational management drives the utilization of a critical resource – train crew. Given that the train workings are driven by the need to meet demand, track access and rolling stock utilization, the next downstream area to generate efficiency is crew management. The complexity of the crew management process makes it a target not only for automation, but also for optimization. To maximize the potential to extract efficiency improvements it is necessary to consider the process end-to-end.

Figure 1. The Crew Management Process

Given the increasing costs associated with training and retaining crew, and the competitive advantage that well trained, experienced and motivated crew provide to a rail company it is appropriate that, as a resource, they are managed in a dedicated manner. For over a decade Opcom has focused on how to increase the efficiency of crew management. To understand the Opcom approach, the underlying crew management process must be considered. The process area that is targeted for improvement starts directly after train movements have been planned and goes through to crew administration.

2.1 Crew Scheduling

The task of crew scheduling involves the construction of days of work for crew (crew diagrams) covering all revenue generating trips and other train workings so that:

- The crewing requirements of each piece of work in the timetable are satisfied
- Each crew member may operate all the work assigned to them within the terms of the appropriate industrial award and other agreements
- Crew lifestyle attributes are catered for
- An agreed measure of performance is optimized
Many crew configurations are possible. A crew can consist of a driver only, a driver and a guard (or conductor), or a driver and cabin crew. The major contributions to the measure of performance are usually the number of crews and the total paid hours.

2.2 Crew Rostering

The objective of rostering is to construct periods of work for crew, covering all schedules so that:

- The crewing requirements of each schedule are satisfied
- Each crew member may operate all the work assigned to them within the terms of the appropriate industrial award and other agreements
- Crew lifestyle attributes are catered for
- An agreed measure of performance is optimized

Similar to scheduling, the major contributions to the measure of performance for rosters are usually the number of crews and the total paid hours.

A roster can be viewed as consisting of three layers:

- **Master.** The master roster is the planned roster that would always operate if there were no operational or crewing changes.
- **Period.** The period roster is a planned roster for an operational period that is updated to allow for changes to the work to be covered and is updated for known crewing changes such as planned annual leave and also updated to satisfy crew requests such as swapping work between crew. The system manages such things as rotating crew on roster lines when moving from one period to another.
- **Daily Roster.** The daily roster begins life as a copy of the period roster and is then updated to allow for changes up to and including the day of operation. Note that when the period or daily roster is being changed, the historical daily roster may be used when checking the legality of the current roster.

2.3 Day-of-Operation Management

Day-of-operation management starts with the planned daily roster and finishes with another roster layer containing the work actually performed. As operational changes occur throughout the day the planned daily roster is updated based on decisions made by crew managers. All relevant information must be available for appropriate crew management decisions to be made. Moreover, the impact of those decisions must be determined and reflected in subsequent planned daily rosters.

At the end of the day-of-operation a record of the actual activities worked must then be passed to the appropriate administration systems.
3 AN OPTIMISATION APPROACH

Opcom has developed an approach to crew management that utilizes computerized optimization to produce rail crew schedules and rosters for actual operational implementation. The optimization approach can also be used to conduct strategic scenario analysis providing answers to ‘What if?’ questions. The fundamentals of our optimization approach are outlined below.

3.1 Schedule Optimization

A crew schedule consists of tasks. Tasks are the indivisible pieces of work that are to be scheduled. These represent the rows of a set-covering problem. A task is usually part of one or more timetabled trips, and usually starts and ends at a relief point. A task may also include preparation or stabling activities, and the turnaround activities at the end of the line. There are many rules that are captured in the system concerned with the very precise definition of tasks.

Each task may be operated by one or more depots. The available depots are determined by road knowledge and traction knowledge.

Travel information is pre-calculated. The information calculated includes:

- Depot-to-Task, how to travel to each task from each depot
- Task-to-Depot
- Depot-to-Crib-to-Task, how to travel to a task from a depot, but fit in a crib first
- Task-to-Crib-to-Depot
- Task-to-Task, how to travel from one task to another task and whether it is possible to crib in the interim

Traveling can include walking, going by taxi, or as a passenger on another train. For best solutions the travel model must be very detailed.

A schedule is a collection of tasks. The core of the system is the routine that checks a schedule for legality and cost. It makes use of travel information for this, and also restricts its search to those depots and shift types that are legal for all trips. After quick checks on total mileage and that all the tasks can connect, the main task is to determine where to put the crib. When all other checks pass, a final check is made on miscellaneous restrictions. These include specific to rail company items such as limits on the number of a type of trip or activity.

3.2 Roster Optimization

A roster is an assignment of work (schedules) to staff over a period of time.

Within rostering there are two major optimization steps, generation of the roster patterns and assigning schedules to the lines of work:

- **Roster Pattern** – A roster pattern is generated to cover all the work in the schedule set with the minimum number of crew lines given the number of days-off required in the period and the pattern the days-off must take.
- **Roster Lines** - Once an optimal roster pattern has been generated schedules are assigned to the blank lines of work satisfying hard and soft rules. Hard rules include the total number of hours
required in a single line (i.e. the target work hours for crew in a roster period) and that there is proper shift separation within a line (i.e. and early shift can not follow a late shift). The soft rules minimize the variability between each roster line to ensure that lines are equitable and limit the variation in sign-on times on different days within a line.

3.3 The Process

A useable framework for the problem must be established so that the algorithms can be applied. The stages that Opcom uses to define and perform an optimization are:

- **Stage 1: Understand the applicable award rules for crew and load the timetable data into Opcom’s computer software**
  - Liaison with the client to establish requirements and analysis of the available data to ensure its completeness and correctness
  - Loading of the train workings, rules and other client supplied data into the OPCrew data set
  - Loading of timetable data into the OPCrew timetabling system, either by direct electronic transfer or manually

- **Stage 2: Calculate the crew schedules**
  - Utilization of the OPCrew software to automatically generate crew schedules

- **Stage 3: Develop roster pattern**
  - Based on legal patterns develop the roster shift patterns for the master roster (eg after five consecutive late shifts three days off must be given before early shifts can be started).

- **Stage 4: Generate the lines of work**
  - Assign the optimized schedules to the patterned roster to produce the “no-name” roster.

- **Stage 5: Assign crew to lines**
  - Based on crew availability assign the crew to the period roster (in a bidding and bumping roster allocation system, the “no-name” roster would be posted at this stage).

- **Stage 6: Manage Changes**
  - Update the crew schedules and rosters based on timetable and crew availability changes. Previously used crew schedules can be reapplied to new timetables and a re-link operation performed to ensure that any new work is covered.

- **Stage 7: Manage the day-of-operation**
  - Using the daily roster and other provided information, manage the day-of-operation changes.

- **Stage 8: Capture actuals and manage performance**
  - Record the actual daily roster and feed information into administrative systems.
  - Generate reports and KPIs eg:
    - Crew utilization
    - Task breakdown
Variation report for planned against actual daily rosters

3.4 Inputs to the Process

The major inputs into the process are the:

- **Working Timetable** - Each service in the *working timetable* is generally referred to as a *train* or *trip* (also contains other train movements such as *empty trips*).

- **Train Workings** - Associated with the timetables is a list known as the Train Working (or Train Roster) that assigns the rolling stock to cover the timetable. Each entry in this working is referred to as a *run*, which is a sequence of trips assigned to a particular set of rolling stock.

- **Operational constraints** - Timetables list the route each train must follow through the network and the arrival and departure times for each stop along the route. However, crew schedules must also take into account the times needed by crew to perform extra functions associated with crewing a train such as the time taken:
  - To walk between the sign-on or sign-off point and the train
  - To prepare a train at the start of a run
  - To secure a train at the end of its run
  - For crew to take mandatory rest breaks known as ‘crib’
  - To walk from a train to a designated lunch room and return
  - For crew to travel passenger from one train to another

- **Work hours** - An upper limit on the number of hours that a crew can be rostered to perform

- **Extra tasks** – There is a need to schedule crew to cover trains not listed in the working timetables. These extra services arise from various operational considerations including the need to move between stabling points and stations and to shut down trains after cleaning

- **Award rules** - Almost any kind of award structure can be catered for in the model used by OPCrew. The details of the award include things such as:
  - The duration of a block of work
  - The minimum and maximum allowable breaks between blocks
  - Sign-on/sign-off allowances
  - Limits on corridor running
  - The minimum and maximum worked time and paid time
  - The times when overtime applies
  - Walking times
  - Preparation times, etc

- **Intangible Factors** - In addition to the actual payment rates for crew, a range of notional values for intangible factors can be used to guide the optimization process towards a desired objective. These are determined after establishing the client’s goals. For example, short shifts may be required at certain depots and certain times of day.
3.5 A Unique Approach

At Opcom we believe that we have developed a unique approach to train crew management. The three principles that we have applied throughout the development of our approach are:

- **Automation is not optimization** – There is obviously merit in using systems to capture and manipulate data and to automate a previously onerous manual process. Indeed a large portion of our approach is underpinned by such techniques. However, in order for all the efficiency improvement opportunities to be revealed it is necessary to use higher-level techniques. Opcom’s optimization approach provides for greater efficiencies than simple automation. By combining our algorithmic and systems expertise in our optimization approach we have been able to mine greater value from the crew management process.

- **Trains have different operational, and hence crew, characteristics than buses and aircraft** - It is feasible to modify an existing crew scheduling and rostering system that has been developed for use in another industry for use in rail operations. For example, some of the basic algorithms used in Opcom’s approach are the same as those used in bus scheduling. However, the unique operational characteristics and constraints of rail operations are best addressed by an approach that has been developed for the rail industry. Opcom’s approach has been developed specifically for, and in conjunction with, the rail industry.

- **Urban and long-distance trains have different optimization drivers** – Opcom has developed a modified optimization engine for long distance trains in order to address their particular characteristics. Table 1 indicates some of the basic differences between the urban and the long distance train crew problem.

Table 1. Urban versus Long Distance Train Crew Problem Characteristics

<table>
<thead>
<tr>
<th>Urban Crew Scheduling</th>
<th>Long Distance Crew Scheduling</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Multiple Depots</td>
<td>Multiple Depots</td>
</tr>
<tr>
<td>2. Road Knowledge Required</td>
<td>Road Knowledge Required</td>
</tr>
<tr>
<td>3. Sign On/Off at same Depot</td>
<td>Out and Back Pairs (Roster Returns)</td>
</tr>
<tr>
<td></td>
<td>Cross-over jobs (driver swaps with oncoming train to start &amp; finish at same depot)</td>
</tr>
<tr>
<td>4. Shifts up to 9 hours maximum</td>
<td>Shifts up to 12 hours (Typical returns are: 8-10 hours out, 8-12 hours rest, 8-12 hours return)</td>
</tr>
<tr>
<td>5. Key difference: 24 hour pattern</td>
<td>Key difference: Multiple day cycle (eg 7 day)</td>
</tr>
<tr>
<td>6. 2 – 4 blocks per day (up to 10 pieces of work per day)</td>
<td>2 – 4 blocks per return (typically 2 – 4 pieces of work)</td>
</tr>
<tr>
<td>7. Aim: Minimize cost. This approximates to</td>
<td>Aim: Minimize cost, but must also keep</td>
</tr>
<tr>
<td>minimizing shift numbers</td>
<td>spare travel to a minimum</td>
</tr>
</tbody>
</table>
4 AN OPTIMAL SYSTEM: OPCREW

As Opcom’s approach to optimizing crew management developed so did the system framework that was used for deployment. The end result of this development is OPCrew. OPCrew is a system for automatic, optimized rail crew scheduling and rostering. It embodies Opcom’s approach to crew management and enables the benefits associated with that approach, that is significant cost savings, reduced crew planning cycle times, more equitable crew rostering and comprehensive management information. The system has been specifically developed for the rail industry and is suitable for both urban and long-distance rail crew scheduling.

OPCrew is a complete rail crewing software package that combines the automatic construction of crew schedules and rosters with a day-of-operation system. OPCrew is used to maintain all facets of train crewing. The system gathers together timetables, schedules and rosters into the one electronic environment and also allows easy access to reports based on all types of information. The major elements of the system are described below.

4.1 The OPCrew Navigator

The Navigator is an application that presents the individual objects (timetables, schedules, rosters) within the OPCrew Database to the user. It is primarily used to manage the timetables, rosters and schedule sets held in the OPCrew database.

The Navigator provides a link between the objects within the OPCrew database and the Editors (Timetable Editor, Infrastructure Editor, Schedule Set Editor and Roster Editor) that are designed to allow the user to view and edit these objects.

The Navigator provides the means for users to cut, copy, rename, paste, delete, publish and change the permissions of the objects within the database that are visible to the user. It also allows users to create new timetables, rosters and schedule sets.

Figure 2. OPCrew Navigator

4.2 The OPCrew Infrastructure Editor

The OPCrew Infrastructure Editor is used to build and maintain the physical infrastructure of the rail system. It is used to edit and maintain:
Rail Crew Scheduling and Rostering

• Network locations
• Roads
• Sections (network arcs)
• Train types
• Crew depots
• Railway lines

The OPCrew Infrastructure Editor is launched from the OPCrew Navigator.

4.3 Timetable Management Subsystem (TMS)

The objective of the TMS is to maintain timetables that require crew schedules and rosters. Users can manipulate timetables to reflect any changes due to daily train changes or permanent timetable changes.

The OPCrew Timetable Editor is used to:
• Import data from timetable planning systems (Capture/Proving)
• Edit OPCrew timetables
• Edit train workings

The Timetable Editor incorporates a Timetable Reporter that provides comprehensive information on the timetable. The available reports are:
• Train usage
• Starting and stabling
• Validation

4.4 Crew Scheduling Subsystem (CSS)

The objective of the CSS is to construct days of work for crew (crew diagrams/schedules) covering all passenger carrying trips and other train workings. The Crew Schedule Editor contains:
• A flexible crew rule definition module
• World leading optimization technology
• Full GUI editing
• Decision support tools
• Schedule legality and distance checking
• Trip coverage checking
• KPI and other reports including:
  o Complete schedule set
  o Individual schedules for issue to crew
  o Train coverage
4.5 Schedule Set Optimization

Schedule Set Optimization is the process where a timetable is used to produce a complete set of crew schedules to operate the timetable. The schedules produced will:

- Have the minimal overall “cost”
- Obey all the rules specified in the Schedule Set Editor Rules
- “Cover” all of the trips in the timetable

Optimization can be performed at two levels:

- **Full Optimization** - When a full optimization is run from a current baseline the exiting schedules are used as a start point and manipulated accordingly. Alternatively a full optimization can be run without a baseline and a completely new set of optimized schedules are generated. This operation is performed on a copy of the existing schedule set so exiting data is lost.

- **Partial Optimization** - A partial optimization affects only a subset of the existing schedules.

4.5.1 Inputs

The Schedule Set Optimization Module takes as its inputs the timetable, the train workings and the rules governing the crew.

In dealing with train workings, the system allows for:
Rail Crew Scheduling and Rostering

- Attach and divide
- Working day variations
- Roads (for alternative paths)
- Relay drivers
- Shunt comments
- Standby times
- Partial coverage
- Preparation or stable overrides

Many rules are catered for including:
- Shift categories and restrictions
- Train types and allowances
- Roads and road knowledge
- Mileage
- Walking rules
- Depots, crib points, relief points and transfer points
- Non-timetabled work
- Restrictions on repetitive work

4.5.2 Outputs

The output of the optimization consists of Outputs:
- Crew schedule sets
- Key Performance Indicators for the sets
- A wide variety of reports

4.6 Rostering Subsystem

The objective of Rostering System is to construct periods of work for crew covering all schedules. The rostering system considers a roster to consist of three layers: Master, Period and Daily. Where relevant, rules are checked independently of the period. For example the system will look at the work a driver did in the last period when checking to see if a work assignment is legal in the current period.

4.6.1 Features

OPCrew allows for:
- A flexible roster rules module
- Automatic construction of rosters
- Allowed day off patterns
- Transitions
• Road knowledge
• Leave
• Full GUI editing including legality checking
• Display of roster and schedule costs and allowances
• Display of fatigue levels
• Multiple roster management

Roster decision facilities include support for:
• Constructing a new roster starting with just the work to be covered and rules governing the amount to be worked in a roster cycle
• Updating the roster on a day to adjust for schedule changes
• Updating the roster on a day to account for a major change such as operating a public holiday on that day
• Suggesting which relief or crew should cover work that is uncovered due to crew absences
• Suggesting which crew should cover work by working overtime
• Checking the roster for breaches of conditions including:
  - Separation between sign-off on one day and sign-on the next
  - Maximum days worked in a row
  - Maximum days worked in any period
  - Distribution of weekends off over the roster
  - Distribution of overtime work
  - Fatigue restrictions
  - Undesirable work patterns
  - Rotation of crew between lines
  - Road knowledge of crew

For all checking and decision support functions the user can choose to check either using the planned roster or using the most recent information. For example when choosing which relief driver to allocate an uncovered schedule to, the system can use the most recent planned and historical daily roster information and if its available will consider the work actually performed on the day of operation.

The roster editor also includes facilities for:
• Multi user editing – A roster can be edited simultaneously by multiple users. For example a clerk can update crew availability details or crew holiday information while rosterers are preparing a roster. The roster will automatically show work as uncovered as soon as the absence or holiday is entered.
• Managing crew properties.
• Managing crew absences.
• Managing the roster for relief and standby staff.
• Managing schedules - For example, at a glance the user can see which schedules have been modified or which schedules are uncovered. The user can also add new unplanned schedules directly into the rostering system or update the roster with a new set of schedules for a particular date.

4.7 Train Crew Assignment Subsystem (TCAS)

The TCAS is the day-of-operation crew management system within OPCrew. It has been designed to present all the necessary information to manage crew on the day-of-operations. Operational activities may include the allocation of new work to available crew or identifying and reallocating work that is uncovered due to a crew absence. TCAS data is derived from the relevant roster(s) for the day and includes all timetable, schedule and daily Rostering information. It also includes fatigue indexes, next shift and mileage data.

TCAS can:
• Display all details relating to a piece of work:
  o The schedule arriving at a depot, the platform number, the schedule that is relieving the current schedule
  o The run (Zig-Zag) of connected trips for a train
  o The available crew, broken down into standby, passenger and report work activity types
  o The full schedule activities for a schedule
  o Uncovered work through crew being unavailable (late, sick etc)
  o Crew details, such as phone number, next shift and fatigue levels
• Uncover pieces of work unable to be worked by a crew member
• Cover uncovered pieces of work by available crew
• Print modified schedules
• Create new pieces of work not in the timetable or schedule
• Update the roster with the actual work on a schedule to allow for complete fatigue management.
Figure 4. The Train Crew Assignment System (TCAS)
5 THE CASE FOR DEPLOYMENT

5.1 Benefits

The deployment of OPCrew not only delivers the operational effectiveness and agility that train companies require but it also enables a reduction in operating costs.

Specific benefits that can be realized are:

- Crew schedule and roster preparation time is significantly reduced
- The crew schedules and rosters produced using OPCrew can result in significant cost savings. Savings in crew costs of over 5% have been achieved
- The crew rosters produced are significantly more equitable
- The reduced cycle times allow a range of ‘What if?’ scenarios can be examined. Examples of these include:
  - The crewing implications of proposed timetable changes
  - The effect on scheduling costs of a change to the proportion of different shift types
  - The effect of changes to award rules
  - Optimal depot staffing levels
  - The economics of new depot facilities
- The system provides accurate reports on key performance indicators that allow effective management of targeted performance areas
- Increased effectiveness of day-of-operation crew management

5.1.1 What others have learnt

Opcom has worked with both urban and long-distance train operators to develop and refine our methodology and software. For the last ten years Opcom has tackled assignments such as:

- Crewing consultancies
- Productivity Studies
- Train crewing agreement study
- Enterprise bargaining case studies
- Crewing for new timetables
- Freight crewing
- Crewing & rosters for new services and lines
- Crewing & rosters for special events (eg Sydney Olympics)

While working with our clients some common themes have emerged with regard to Opcom’s approach to crew management. As a result of adopting our approach our clients have realized that:

- An integrated approach to crew management allows significant benefits to be gained
- The extra benefits to be gained from optimization over automation are substantial
• The ability to quickly perform scenario analysis is particularly useful in a changing business environment

5.2 Why Opcom

Opcom Pty Ltd is an Australian optimization and information technology company that operates internationally. Opcom focuses on optimization software for transportation applications, which are defined broadly to include public transport by road and rail, product distribution, private vehicle travel and emergency services deployment.

Opcom assists its clients to achieve significant operational efficiencies and service level improvements through efficient resource management and timely availability of information.

Opcom has established a strategy for success centered on the following four main product areas:

• Rail crew scheduling, rostering and related functions
• Public transport journey planning systems for use in call centers and on the Internet
• Distribution and logistics network analysis
• Vehicle routing and travel directions

5.2.1 Differentiators

Opcom’s competitive advantage is based on our ability to combine advanced optimization algorithms, system development expertise and industry knowledge. This unique combination allows us to meet our customers’ complex requirements quickly and effectively. Specifically Opcom is differentiated by:

• Strong rail industry experience
• Expertise in resource allocation and scheduling
• Experience in management of large IT projects
• OPCrew is a proven system
• Opcom’s scheduling and rostering engines are advanced software developed specifically for railways
• Opcom has written and owns the software source code making modifications possible
• High caliber support is available for the use of the software
• Opcom delivers projects to budget

In 1999, Opcom was the winner of the Queensland IT&T Awards for Excellence for its Public Transport Journey Planning project within the Transport Category.

The company was also a finalist in the Information Industries Category at the Premier of Queensland Export Awards for 1999 and 2000.

In 2000, Opcom was awarded the Emerging Exporter Award from the Australian British Chamber of Commerce.
## GLOSSARY

<table>
<thead>
<tr>
<th>Item</th>
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<tr>
<td>Tasks</td>
<td>The indivisible pieces of work that are to be scheduled</td>
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<td>Schedule</td>
<td>A collection of tasks</td>
</tr>
<tr>
<td>Public Timetable</td>
<td>Contains the list of scheduled passenger services (not a complete list of all train movements)</td>
</tr>
<tr>
<td>Working Timetable</td>
<td>Contains all train movements. Each service in the working timetable is generally referred to as a <em>train</em> or <em>trip</em></td>
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<td>Train Working (or Train Roster)</td>
<td>Assigns the rolling stock to cover the timetable. Each entry in this working is referred to as a <em>run</em></td>
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<td>Crib</td>
<td>A mandatory crew rest break</td>
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<td>Trip</td>
<td>A service in a working timetable</td>
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</tr>
<tr>
<td>TCAS</td>
<td>Train Crew Assignment System – used for day-of-operation crew management</td>
</tr>
<tr>
<td>Run</td>
<td>A sequence of trips assigned to be worked by a particular set of rolling stock</td>
</tr>
<tr>
<td>Roster Return (or Barracks Shift)</td>
<td>A full shift outbound, followed by a rest period, and then a full shift inbound (generally applies to long distance rail)</td>
</tr>
<tr>
<td>Cross-over</td>
<td>Crew from a pair of trains heading in opposite directions swap so that the crews finish their shift from where they started (generally applies to long distance rail)</td>
</tr>
<tr>
<td>Zig-Zag</td>
<td>A schematic display of a run</td>
</tr>
</tbody>
</table>