BIOGRAPHICAL INFORMATION

Wolfgang Hall
Senior Consultant/Project Manager
ESRI

## Responsibilities

As a senior consultant and project manager, Mr. Hall is responsible for providing consulting support for clients, managing projects, conducting user needs assessments, developing conceptual and logical designs, creating database and system specifications, and overseeing application programming projects in Logistics and Transportation. Mr. Hall also works closely with business partners in the Utilities, Logistics and Transportation market.

## Past Experience

Fifteen years of experience in logistics and transportation system development and eleven years of experience in consulting and project management.

Selected consulting and project work includes:

- Led capacity management project for **Sears, Roebuck and Company.**
- Led implementation of large-scale technician fleet routing solution for **Sempra Energy**. The system routes up to 2,500 technicians daily in order to optimize work at up to 30,000 client locations.
- Responsible for a routing project to optimize meter-reader staff for **Sempra Energy**. The solution is based on a large, versioned ArcSDE geodatabase with more than 60 million meter-read records.
- Project manager for a virtual advisor real-time traffic module for **OnStar**.
- Mr. Hall worked as a consultant on a logistics project to implement an inspector routing and mapping system for **AAA -CSAA**.
- Consultant on a strategic plan for implementing a statewide GIS for the **Arizona Department of Transportation.**
- Managed ITS implementation for **TRANSCOM** in New York.
- Mr. Hall managed a large-scale GIS logistics project for the **Schindler Elevator Company**

## Educational Information

Diplom Ingenieur, Engineering Degree in the field of communication electronics from Fachhochschule Kiel, Germany, in 1991.

## Professional Memberships

ITS America

# Enterprise Benefits Through Automated Routing and Scheduling

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## ABSTRACT

The use of spatial technology to efficiently manage corporate assets has become a core component of mission critical business applications. Asset management, route planning, supply chain management, sales, and marketing are just a few areas where spatial technology is being embedded as part of an enterprise IT strategy. Routing and scheduling of field crews is a key area in which to streamline the business process. Companies that implement automated route optimization tools see Return on Investment (ROI) typically within two to twelve months by reducing route planning time (by up to 80%) as well as travel and overtime (10–15% reduction).

This paper will outline the benefits of an automated routing and scheduling application as well as the process of obtaining approval for implementation within the organization.

The audience will also receive a brief overview on project implementation issues and system architecture.

## WHY USE AUTOMATED ROUTING AND SCHEDULING?

### *The Manual Process*

Picture this: A wall map in a local office of a regional gas utility company, with hundreds of pushpins scattered all over the area and a group of supervisors huddled in front of it, trying to figure out the most efficient work distribution. Or, visualize a large table, countertop, or floor with stacks of index cards, ready to be sorted for periodic maintenance work, laid out neatly in piles of hundreds waiting to be tackled. Though it may appear more like a game of Risk or Twister, this scenario is far less enjoyable. These employees have their work cut out for them: they are about to make business decisions that will directly impact the bottom line of their organization. Their decisions may have an impact on customer satisfaction. Their work will have a huge impact on the field crews, some of whom may suggest the office staff should have played that game of Twister instead.

**Figure 1: Picture of pushpin wall map**

If you see a hint of familiarity with the above scenario in your organization, don't be surprised: you are not alone. A majority of companies in the service, delivery, repair, or utility market are using very simplistic methods for a planning job that has a significant cost impact. Following are example scenarios from customers I have worked with in the past. Though the company is fictional, the problems are real.

**Example: SuperEnergy Utility**
Let's take a look at a sample utility company, SuperEnergy, with $20M operating expenses spent annually on field crews. The field crews include service technicians, meter readers, and maintenance crews. All of these crews depend on route planning of some sort to make sure the available resources are being used wisely. SuperEnergy has four regional offices; the regions were formed historically via mergers of smaller companies. The regional boundaries are not very efficient since some of the east region's areas could be better served by the west region.

The north region is lucky to have a very knowledgeable field service route planner who knows the area very well. The south region, on the other hand, recently replaced its route planner. Fortunately, the company is using a grid-based assignment process in which field crews are assigned using a map grid. Even though the mapmaker created the grids subjectively, it provides a rough geographic grouping for general purposes.

SuperEnergy adopted the grid system more than a decade ago and by now everybody from office personnel to field staff lives by the grid. That means customers are automatically assigned to these grids in the customer information system (CIS), and service technicians, meter readers, and preventive maintenance crews operate in their respective grid boxes. Unfortunately, grids do not consider rivers, highways, mountain ranges, coast lines, or any other geographic obstacle that may impact travel time and route efficiency. Two service points within a few blocks could be separated by a grid that represents a hard operational boundary—forcing two crews to travel to the same area on the same day. The experienced planner from the north region knows the area well enough to manually compensate for these shortcomings. The south region isn't quite as fortunate. Even though both regions have about the same service point density and geography, the north region runs an average of twelf services per crew compared to ten stops in the south. A management survey reveals that route assignment is only one efficiency factor; the order of stops on the route is at least as important. It turns out that the field staff in the north spend 15 minutes in the morning to plan their day routes by using an Internet mapping program, Yahquest. The 15 minutes is well invested time: despite the additional planning time in the morning, the crews can squeeze in one or two more jobs because they are using street-level drive time estimates.

For SuperEnergy, two additional stops per route turn out to be a 10% gain in efficiency, 10% potential savings that add up to $1M–$2M annually. A small saving over a large fleet can yield very substantial savings!

Two other big problem areas are the matching of technician skill levels to orders and adherence to appointment time windows. All four regions frequently violate the skill-match requirements because the routes have to be completed, and there are only so many staff per grid available. Technicians in the south, east, and west regions frequently violate appointment times because the routes cannot be traveled as planned. Driver accountability poses an additional problem: each of the regions has some employees who will chose their own route sequence and add one or more "unscheduled" stops.

SuperEnergy is also responsible for meter reads and maintains a staff of about 100 meter readers who read the 500,000 meters on a monthly basis. The group has a very high turnover rate, particularly any time the temperature rises or falls or the rainy/snowy season begins. Therefore, local knowledge is very limited and training new staff is a constant activity performed by experienced meter reader supervisors. Route planning is done via land-base maps in CAD file format, but the planners also spend a significant part of their time redlining the maps in order to depict new development areas. The group maintains its own meter-read database system that is loosely integrated with the CIS. Meters are aggregated by street block. Each block has a sequence number so that the routes can be sequenced in an optimal order. Ironically, the block-level reference and database attributes resemble a simple form of a Geographic Information System (GIS) system, but most supervisors likely never even heard the term "GIS." Since the meter-read sequence was manually created and changes frequently, particularly in fast growth areas, the group relies mostly on the local knowledge of their staff. When new employees are hired, routes have to be readjusted in order to make up for loss in read-speed and local knowledge.

The third field crew includes staff that performs maintenance and inspections. One of the tasks is the mandatory inspection of service lines. With a half million service lines, this is a time-consuming task that has to be planned well. One initial thought was to use the meter reader routes to perform the inspections, however, this turned out to be infeasible because of the different time requirements for reading versus inspecting.

SuperEnergy had just recently hired a GIS consultant for work on an AM/FM solution. The GIS consultant was also familiar with GIS-based routing and scheduling tools and suggested an enterprise-wide GIS implementation using a high-quality land base with accurate addresses for geocoding (address locating on a map) and street data that supports routing, as well as accurate drive-time calculation. Let's take a look at these routing and scheduling tools.

## WHAT ROUTING AND SCHEDULING TOOLS ARE AVAILABLE?

In order to optimize operations in the examples above, these tools can be deployed within an enterprise GIS:

- Service Area Management
- Service Routing (day routes and schedules)
- Meter Reader Routing
- Periodic Routing and Scheduling

**Service Area Management** can easily be supported with the same GIS mapping tools used by fire departments to define response-time areas. The service area tool allows the planner to define a set of travel distances from a candidate office (e.g., 15 min., 30 min., 60 min.). The GIS will calculate polygon areas around these offices based on average drive times on highways, major roads, and local streets. For further analysis these polygons can be overlaid with demographic information such as customer density per block group. Some GIS provider offer polygon-based territory planning systems that can be used to define boundaries based on service point demands. For in-depth analysis, performing spatial analysis using service area polygons, demographic data, and territory planning data may be the best choice.

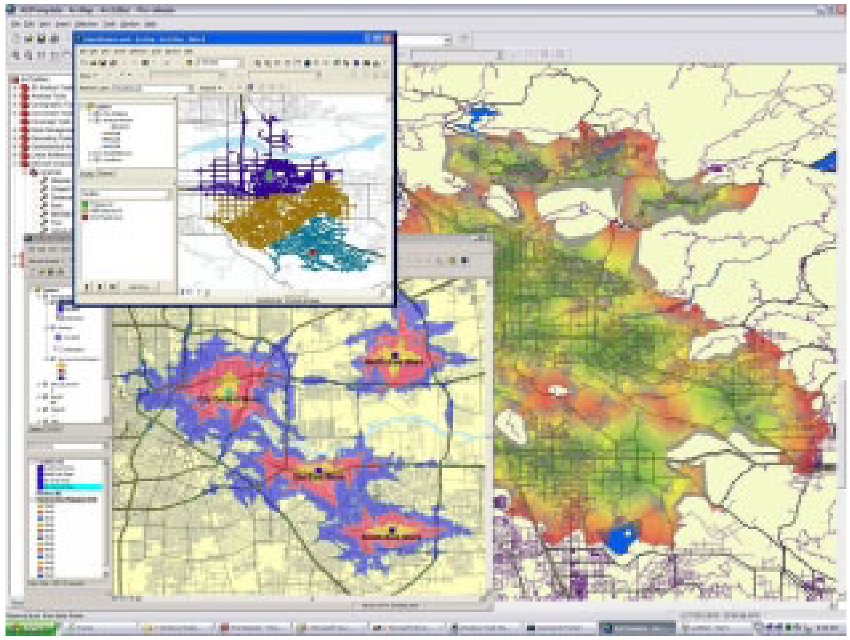

Figure 2: Service area calculation based on travel time

**Service Routing** tools (point-to-point routing) are the most widely used GIS routing and scheduling tools in the utilities market. These tools typically provide the ability to define a number of routes with special characteristics (e.g., senior service technician, training route, collection route, etc.). Service orders can be loaded into the routing tool from a CIS or dispatch system. Most tools use a "traveling salesman" algorithm that optimizes the sequence of stops on a route. This feature alone is typically the "low hanging fruit" since it can be implemented without changing existing route assignment processes. More sophisticated tools will also provide optimized assignment based on skill sets, employee available times, appointment times, and cost considerations such as paid overtime. Off–the-shelf products can handle utility specific business rules that will cover 80%–90% of companies needs. The remaining 10%–20% may require some tailoring or customization in order to gain the full level of possible optimization.

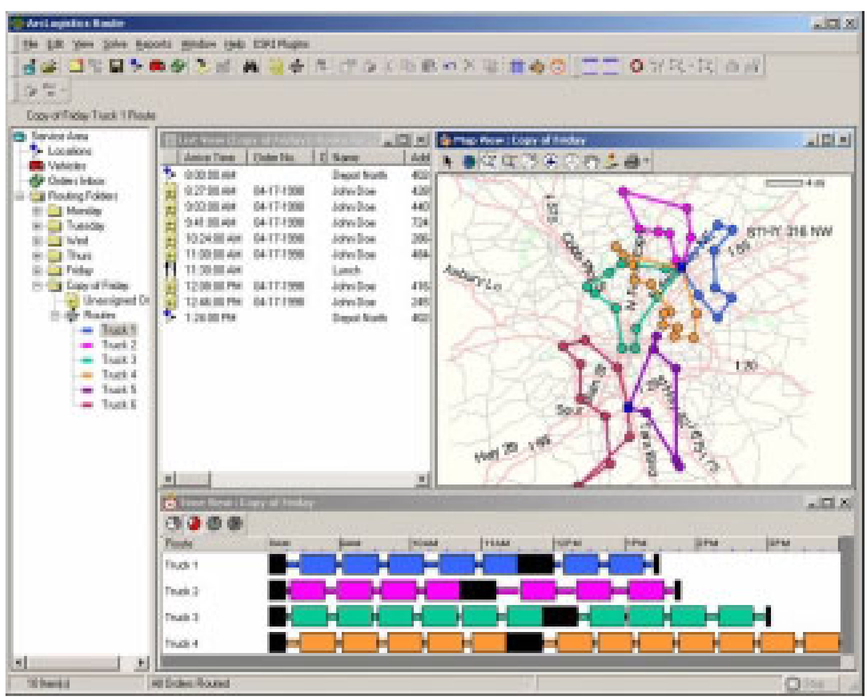

Figure 3: Service Routing System

Point-to-point service routing is typically performed as next-day routing (build routes for the following day) or same day routing (supports same-day dispatching, emergency order assignment, route re-sequencing due to added or cancelled work).

**Meter Reader Routing** is often an overlooked area for optimization. Most companies invest large sums in field equipment but miss out on substantial savings due to better route planning. Some mobile device manufacturers offer only simple route planning support, but realistic modeling requires an accurate routable street data set and GIS-based districting and route sequencing mechanisms.

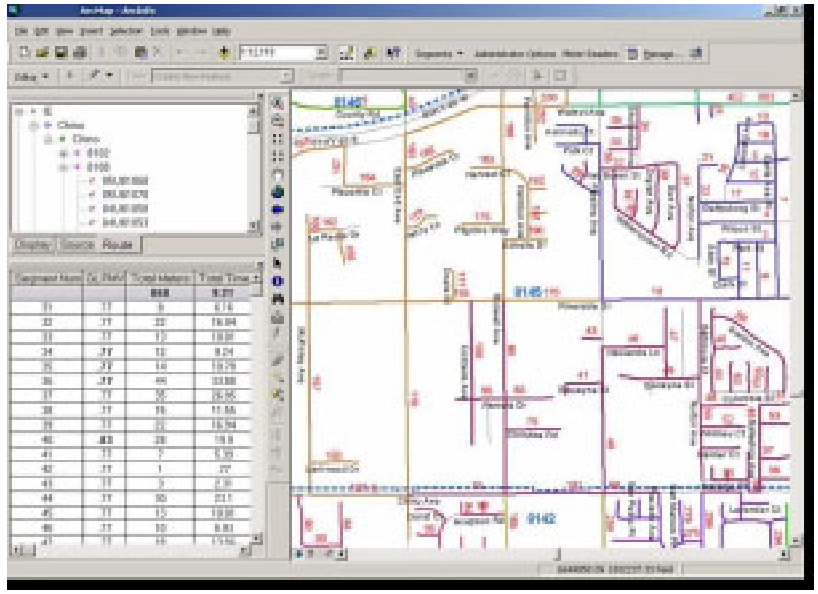

**Figure 4: Meter Reader Routing System**

The strength of a GIS-based meter-reader routing tool lies in the combination of modeling real street drive and walk times and the consideration of historical meter-read times. Routes are easily balanced based on the efficiency of senior versus new employees, and each route provides a suggestion for the optimal drive or walk sequence.

A slight variation of the meter-reader routing system can also be used for inspection work (e.g., service lines). The main difference is that the street network will be complemented with a pipe or cable network. Inspectors can now be routed using both streets and the utility network. This method provides accurate results for inspections in areas with no streets (backyards, cross-country, etc.)

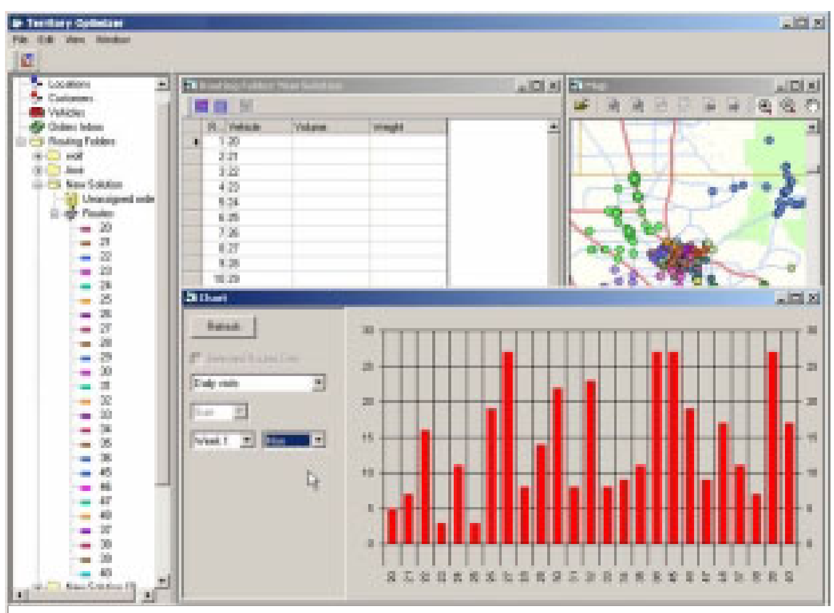

**Figure 5: Territory Optimizer (Periodic Planning)**

**Periodic Routing and Scheduling** tools are the most complex routing problems that can be addressed. These tools include most of the capabilities of the service routing tools but add scheduling over a long time period as a new dimension for optimization. The time period can span anywhere from one week to one year and considers repeat visits to service points (or delivery points). Visits can be daily, weekly, bi-weekly, monthly, quarterly, etc. Each visit is optimized based on travel time, employee availability, overtime, appointments, capacity, customer preferences and many more attributes. Periodic Routing and Scheduling also includes Territory Optimization (Territory Planning).

## BENEFITS

The cost for a routing and scheduling system varies depending on the need for customization and enterprise integration. In the example above, SuperEnergy could implement a simple, stand-alone desktop solution for service routing in all four regions for under $50K.

Experience with dozens of past service-routing implementations shows a typical route efficiency gain of 10–20%, not including time saved in the office due to a streamlined planning process. For SuperEnergy this means savings of $1M to $2M annually. The quick ROI leaves room for more than a simple stand-alone system. SuperEnergy could work with a consultant to implement an enterprise integration and tailoring or customization of some of its business rules. An enterprise-wide integration with centralized database and client-server communication can easily become a six-figure investment. But even the nation's largest routing projects, with tens of thousands of vehicles, a high level of business rule customization, and monthly street data updates, experienced an ROI within one or two months and enjoy an ongoing return on their investment. Some of these large clients have been saving tens of millions of dollars annually since implementation of their system.

Typical benefits include

- Overtime reduction (5–20%)
- Increased customer satisfaction due to tight appointment times.
- Reduced travel time and accidents (10–20% travel reduction)
- Reduced time spent in the office for route planning (80% reduction)
- Higher driver accountability (via comparison of planned versus actual miles)

## APPROVAL PROCESS

Approval for any capital investment can be a lengthy process. It is very important to get an executive sponsor on both the business and the IT side. We have seen organizations that take ownership of the implementation on the IT side as well as on the business side and either way had an efficient implementation process. Particularly if a routing and scheduling system implementation is not initially championed by executive management, a thorough cost/benefit analysis is a must. Fortunately, the potential savings make this process easy.

It has worked well in the past to take a snapshot of the existing routes and hire a consultant to produce an optimized solution for these routes. A before and after cost comparison (10-20% reduction) will quickly educate executive management on potential savings. Overtime and travel time reduction as well as balancing the work load between employees will help to bring unions on board. In addition, scheduling accuracy (meeting appointment times) and geographically tighter routes that eliminate unnecessary drive time will help to get approval among the field crews. Simply visualizing in a GIS how work is performed currently is valuable in many ways.

Routing systems come in many different flavors from stand-alone desktop applications to Web service oriented implementations. The market offers a variety that should satisfy enterprise IT requirements including constraint bandwidth, centralized maintenance, and the like. Again, a GIS consultant will be able to draft a system architecture that will meet the IT department's requirements.

In summary, it is critical to involve an experienced consultant for performing a cost/benefit analysis. The use of real route data (typical snapshot) will prevent guessing and will base ROI estimates on reality.

Also, make sure these groups are involved in the process from the beginning.

- Executive level sponsor
- Management
- Project manager with IT background
- Business analyst
- Route planners
- Route supervisors
- Field staff
- GIS coordinator
- Training department (in large organizations)

## PROJECT IMPLEMENTATION

Unless a simple-to-implement, off-the-shelf desktop routing solution is chosen, a system implementation should follow a proven project cycle including frequent milestones for risk mitigation.

Project tasks should always include these main steps:

1. Functional requirements analysis including a thorough use case analysis. Use case analysis makes sure that the business processes and rules are captured in plain, understandable English and that the requirements can be translated into an object-oriented software design.
2. System architecture and design including scaling requirements and interfaces to existing systems and databases.
3. Development of a graphical user interface (GUI) prototype in order to validate the use cases and refine the usability of the design. The prototype will evolve into the production system and is not a throw-away development effort and deliverable.
4. Iterative review process including field personnel
5. Final development
6. Unit-level testing
7. User testing
8. Pilot rollout
9. Adjustments, if needed

10. Final rollout
11. Technology transfer to ensure self-sufficiency in the company
12. Support

Implementing an automated routing and scheduling solution will have a cultural impact. Keys for a successful implementation include:

- Involve field staff from the very beginning.
- Recruit well-respected (by field staff) advocates.
- Educate before rollout (expectation management).
- Implement all pertinent business rules used in different regions.
- 80/20 rule does not apply for business processes—Make sure your business process is properly reflected in the new system.  Any cost spent on tailoring or customization will pay back in weeks or months and will generate satisfaction and more future savings.
- Allow for a gradual implementation (horizontally and vertically).

## SYSTEM ARCHITECTURE

The example below is a system architecture for a routing and scheduling implementation that provides rich client and browser access in a Web-services oriented architecture:

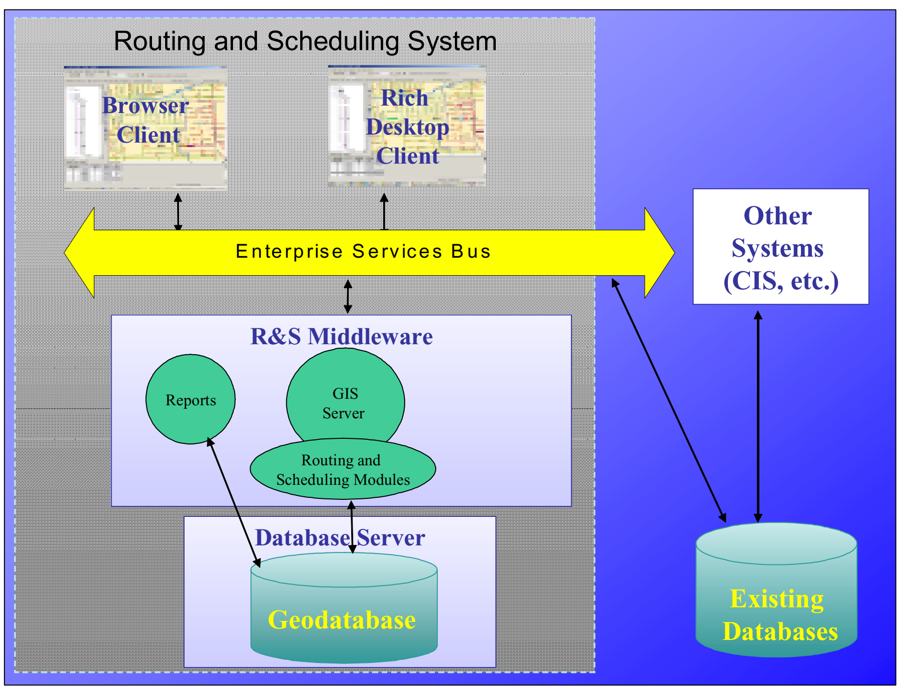


**Figure 6:  Sample Routing and Scheduling System Architecture**

## SUMMARY

The implementation of routing and scheduling systems requires a well defined planning and approval process. It is important to involve various groups from executive management to field staff in the decision-making process.

The quick potential ROI of automated routing and scheduling systems simplifies the justification process. In order to provide accurate cost/benefit analysis the support from a GIS routing subject matter expert is highly recommended.

Automated GIS routing and scheduling systems are available in many variations and for various field groups (e.g. sales, service technicians, maintenance crews, meter readers).

GIS companies also offer tailoring and customization to adapt fully to each companies business process. This adaptation often allows companies to gain even more efficiency. Particularly for large fleets even a little bit of extra saving per route will result in savings of millions of dollars annually.