



Time-Based Routing for Field Service

Using a Time-Based Approach to Yield Greater Efficiencies and More-Reliable Schedules

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Executive Summary

In a comparative analysis of three routing methodologies for mobile workforces, time-based routing yielded more-accurate travel times than either linear-distance or street-level routing.¹ Time-based routing outperformed street-level routing in a test case with a large sample size (more than 6,000 trips) in urban, suburban, and rural environments. Consequently, time-based routing results in schedules that are more stable throughout the day and more thoroughly optimized across an entire enterprise, while consuming minimal computing power and eliminating a single point of failure.

Introduction

How do you schedule your morning commute: by distance or by time?

Let's say you use a widely available, online map application to plot the route from your home to your workplace. The software presents the best option as a 17.5-mile route on a combination of freeways and surface streets, taking an estimated 30 minutes. If you need to arrive at work at 8:00 a.m., you would set the alarm for 7:30, right? Of course not. You would arrive late every day, because your schedule doesn't account for getting dressed, eating breakfast, or doing any of the other routines that make up a typical morning. You probably wouldn't keep your job for long.

Yet that's exactly how most automated management software handles routing and job scheduling for field service personnel. It also explains why a mobile employee's daily schedule typically turns into a pipe dream by midmorning.

Routing methodology—the procedure for plotting a path from Point A to Point B and estimating the travel time—profoundly affects scheduling for field service personnel. Overestimates of travel time sap workforce productivity by scheduling too few jobs per worker per day. And underestimates of travel time result in late arrivals, angry customers, and increasingly disrupted schedules as the day wears on, necessitating costly overtime or the employment of expensive contractors. In many respects, the key to mobile workforce optimization lies in accurately assessing travel times for multiple routes between multiple appointments.

¹ Based on a 2012 comparison study conducted with the cooperation of a customer using the time-based routing functionality embedded in Oracle Service Cloud



On the following pages, we examine the pros and cons of three distinct routing methodologies:

- » **Linear-distance (“as the crow flies”) routing.** As the easiest-to-understand routing methodology, it serves as an entry point for discussing the intricacies of the others.
- » **Street-level routing.** This common approach is used by most mobile workforce management systems, as well as by widely available map applications and satellite-based, in-vehicle navigation systems available to consumers and businesses.
- » **Time-based routing.** This routing methodology is used exclusively in Oracle Service Cloud’s Field Service solution.

Based on a careful analysis and on data from a 2012 comparison study conducted with the cooperation of a customer using the Field Service solution in Oracle Service Cloud, time-based routing clearly emerges as the superior choice. It predicts arrival times with the greatest accuracy and consistency, resulting in optimized workdays, more-dependable schedules, and less overtime. Finally, as applied in the Field Service solution, time-based routing proves more dependable, because it functions mostly independently of other sources to obtain the travel times used in street-based routing.

Linear-Distance Routing

According to Euclidean geometry, the shortest distance between two points is always a straight line. The principle makes sense intuitively, and grade-schoolers demonstrate it every day by laying down a ruler on a map to measure distance. We generally use it to judge distances “as the crow flies.”

For scheduling and routing purposes, automated systems use an average fixed speed over a linear distance to estimate travel time. (Instead of an *average fixed speed*, some systems use the *average prevailing speed* for particular times of day, which yields more-realistic estimates.) Again, the calculation is so simple that any middle-schooler can do it: distance \div speed = travel time.

Figure 1:
Linear-Distance Routing

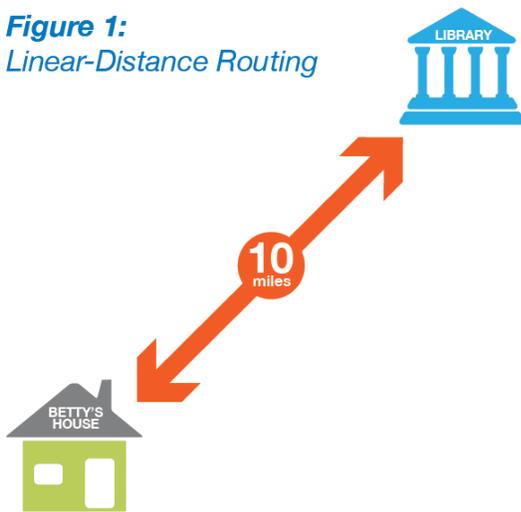


Figure 1. As the crow flies, the library is 10 miles from Betty's house, and the average speed is 24 mph, or 0.4 miles per minute. By the linear-distance method, Betty can expect her one-way trip to take 25 minutes.

For software, simple calculations mean fast calculations, and calculation speed matters with large mobile workforces. Scheduling thousands of trip segments daily for hundreds of mobile employees consumes both time and computing power, so the linear-distance method clearly offers significant benefits.

However, the problems with this method quickly become obvious in real-world situations. As shown in Figure 1, Betty needs to return a book to the library in a hurry. As the crow flies, the library is 10 miles from her house, and the average speed is 24 mph, or 0.4 miles per minute. By the linear-distance method, Betty can expect her one-way trip to take 25 minutes ($10 \div 0.4 = 25$).

But Betty isn't a crow. She needs a car; the car needs roads; and roads seldom run straight. Furthermore, she must leave her car in the parking lot and walk a short distance to the building. Those earthbound realities completely throw off her predicted door-to-door travel time, which highlights the inherent weakness of the linear-distance method. Because it doesn't account for topographic obstacles, construction detours, or anything else that forces a deviation from a straight-line travel path, using it alone yields inaccurate travel distances and estimated travel times.

Street-Level Routing

Street-level routing works just as its name implies: it maps the best path for a vehicle traveling on a network of streets from Point A to Point B, and then estimates the travel time.

Figure 2 shows how street-level routing would calculate the travel time for Betty's errand to the library. The system evaluates all available routes, choosing Mockingbird Lane as the shortest. Traveling 16 miles on Mockingbird Lane at an average speed of 24 mph, Betty can expect her trip to take 40 minutes.

Figure 2:
Street-Level Routing



Figure 2. Street-level routing maps the best path for a vehicle traveling on a network of streets from Point A to Point B, and then estimates the travel time.

The most significant advantage of street-level routing over the linear-distance method becomes obvious immediately: it estimates travel times more accurately, because it accounts for the nonlinear routes dictated by street layouts.

But even street-level routing doesn't produce a true door-to-door travel time, because it accounts only for driving distance—that is, time spent on the street.

Street-level routing also carries two less-obvious disadvantages. First, it requires an enormous number of calculations, because it evaluates several possible routes for every point-to-point trip. For instance, managing 1,000 field service personnel, each traveling to six jobs per day, with four possible routes per job, would require nearly 576 million calculations. To make that number more manageable, automated systems that employ street-level routing use heuristics. Even with those shortcuts, however, the calculations still consume time and computing power.

Second, most automated systems that employ street-level routing rely on a single source of data for the maps and travel times used in their calculations. If that source goes offline or fails in any other respect, scheduling becomes impossible—an unacceptable possibility for enterprises with mission-critical mobile workforces.

Time-Based Routing

Used exclusively in Oracle Service Cloud's Field Service solution, time-based routing takes a different approach. For scheduling purposes, time-based routing ignores distances, measuring the door-to-door travel time for mobile employees and compiling a historical database. It actually learns travel times through experience.

As shown in Figure 3, the Field Service solution learns that Betty's trip from her house to the library's door takes 47 minutes. It accounts for drive time, regardless of the route she takes. It accounts for walk time, regardless of where she parks her car. It accounts for packing time, regardless of how many books or other items she needs to gather. In other words, it calculates travel time much the same way as you plan your weekday mornings: you set your alarm, having learned how long it normally takes to make coffee, eat breakfast, brush your teeth, and drive to work. And, like you, the time-based routing in the Field Service solution becomes more accurate with experience. For example, when construction-related road closures, cyclical traffic congestion, and other changing conditions disrupt travel, the Field Service solution adjusts its estimated times based on the real-world data it compiles.

Figure 3:
Time-Based Routing



Figure 3. Time-based routing ignores distances, measuring the door-to-door travel time for mobile employees and compiling a historical database.

The accuracy of time-based routing derives partly from its use of real-world data, partly from its sophisticated predictive analytics, and partly from its particularized approach. First, it doesn't estimate travel time by applying an average prevailing speed or even the average prevailing speed for a particular time of day. Rather, it maintains a massive database of actual travel times for all company employees who've traveled between those two points in the past. Furthermore, it statistically accounts for Betty's driving style, walking speed, preparation, and a host of other idiosyncratic variables. For instance, if Betty drives more slowly and cautiously than average but walks much faster than average, time-based routing produces estimates that reflect those differences. As a result, time-based routing estimates the time that Betty—and only Betty—takes to go from her home to the library.

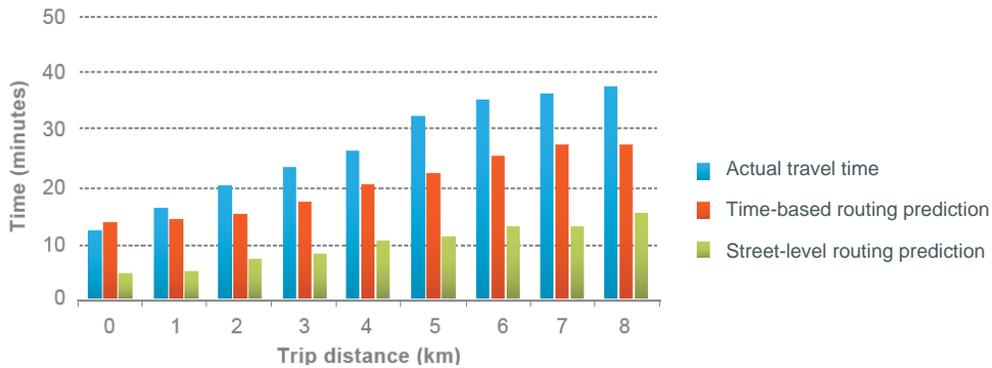


Figure 4. The Field Service solution’s time-based routing is compared to street-level routing in urban areas.

Studies show that time-based routing predicts travel times far more accurately than street-level routing. In 2012, TOA Technologies (acquired by Oracle in 2014) compared the estimated travel times produced by time-based routing with those produced by traditional street-level routing. The comparison involved 6,314 trips in urban, suburban, and rural environments; trip distances ranged from less than 1 km (734 trips) to 19 km (10 trips), with the largest sample size (3,370 trips) comprising 1 km to 3 km trips. As Figures 4 and 5 illustrate, the time-based method delivered estimates much closer to actual travel times than did the street-level method, regardless of trip length and environment.

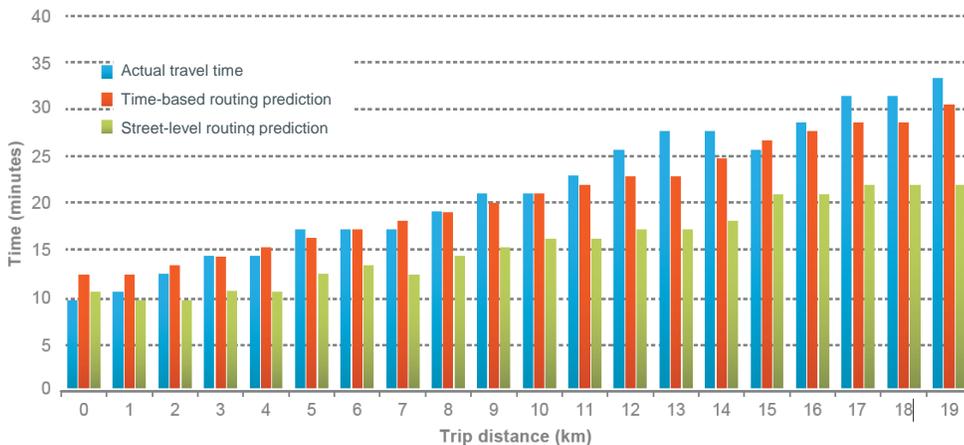


Figure 5. The Field Service solution’s time-based routing is compared to street-level routing in suburban/rural areas.

Most important, the comparison study shows that the larger the sample size, the more accurate the predictions using the time-based routing found in the Field Service solution. For example, in the sample with the most trips (931 urban trips, 1 km to 2 km long), time-based routing proved 180 percent more accurate than street-level routing. In the next-largest urban sample size (445 trips under 1 km), time-based routing outperformed street-level routing by 120 percent. In short, the time-based system used in the Field Service solution actually does learn, as it was designed to, becoming more accurate as it accumulates more data through experience.

Besides producing more-accurate predictions, time-based routing also streamlines the computing process compared with street-level routing. Rather than consuming hours of computing time to create a single day’s schedule, as a system based on street-level routing would, the Field Service solution can route 10,000 jobs in less than four minutes. This speed allows multiple routing executions per day—actually, between 10 and 15 per hour, even for



users with relatively large mobile workforces. And, as employed in the Field Service solution, time-based routing runs independently of any single source for travel times. It can draw its mapping coordinates from any source or from a variety of sources. Because it uses the historical performance of individual users to estimate travel times between points, the failure of any single mapping provider never threatens the day's schedule.

Never Starting from Zero

Obviously, time-based routing looks impressive when it has a historical database from which to draw. However, even when the Field Service solution begins routing in an area where it has no history, it doesn't start from scratch. How it starts depends on the environment in which it is deployed.

In most urban and suburban areas, it draws from a preloaded database of "travel keys"—a unique, highly configurable system that uses the best routes between specific areas, as defined by any geographic marker. By using these travel keys during the first several days of routing in an unfamiliar region, the Field Service solution exploits street-level routing's greatest benefit (estimating travel times with an accuracy second only to time-based routing), while mitigating street-level routing's greatest weakness (consuming time and computing power for many calculations). These travel keys not only help the Field Service solution learn door-to-door times faster for its database used in time-based routing; they also help later, when the system must route between two exact points for which it has no historic data.

In rural areas, the Field Service solution estimates the door-to-door travel times by the linear-distance method until it learns real-world travel times. Because point-to-point routing usually involves greater distances in rural areas than it does in more densely populated areas with denser street networks, the inaccuracies of the linear-distance method's estimates have less impact on the overall schedule. Additionally, to improve the accuracy of estimates, the Field Service solution uses a more sophisticated formula that accounts for speeds typical of certain vehicle types (passenger cars and trucks, for instance) on certain types of trips (longer-distance trips usually involve higher speeds than shorter trips do).

Conclusion

In theory and in practice, the time-based routing of Oracle Service Cloud's Field Service solution estimates travel times faster, more accurately, and more reliably than either of the alternative methods. Because consistently accurate and reliable travel time estimates form the basis for schedules that maximize productivity, time-based routing lays the essential foundation for mobile workforce optimization.



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