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BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte CHRIS LAMBERT, CHRISTOPHER SHOLLEY, and GRAYSON McCLURE BADGLEY

Appeal 2019-002674
Application 13/828,952
Technology Center 3600

Before DONALD E. ADAMS, JEFFREY N. FREDMAN, and RACHEL H. TOWNSEND, *Administrative Patent Judges*.

FREDMAN, *Administrative Patent Judge*.

DECISION ON APPEAL

This is an appeal[1,2] under 35 U.S.C. § 134(a) involving claims to a system for dispatching a driver. The Examiner rejected the claims as reciting non-statutory subject matter. We have jurisdiction under 35 U.S.C. § 6(b). We affirm but designate our affirmance as a New Ground of Rejection.

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[1] We use the word "Appellant" to refer to "applicant" as defined in 37 C.F.R. § 1.42. Appellant identifies the Real Party in Interest as Lyft, Inc. (*see* Appeal Br. 2).

[2] We have considered and herein refer to the Specification of Mar. 14, 2013 ("Spec."); Non-Final Office Action of Mar. 22, 2018 ("Non-Final Act."); Appeal Brief of Aug. 21, 2018 ("Appeal Br."); Examiner's Answer of Dec. 27, 2018 ("Ans."); and Reply Brief of Feb. 14, 2019 ("Reply Br.").

Statement of the Case

Background

The invention is drawn to a "system for dispatching a driver" (Spec. ¶ 17). The Specification explains that

> when a potential rider places a ride request to a system for connecting a driver and a rider, the system selects a driver and delivers the ride request to the selected driver. The driver either accepts the ride request and begins driving to meet the rider; or ignores the ride request. If the driver ignores the ride request, a next driver is selected, and the process is repeated until a driver accepts the request or there are no more drivers to deliver the request to.

(*id.* ¶ 18). The Specification teaches "ordering of drivers to deliver the request to in order to maximize system efficiency, i.e., to maximize the total fraction of drivers carrying passengers over the course of a day" (*id.*).

The Claims

Claims 1–8, 11–14, and 20–24 are on appeal. Independent claim 1 is representative and reads as follows:

> 1. A system, comprising:
> at least one server computer comprising at least one non-transitory computer readable storage medium storing instructions that, when executed by the at least one server computer, cause the system to:
> receive, from a computing device of an available driver, a location of the computing device of the available driver; and
> position the computing device of the available driver by:
> determining, for the available driver, a first expected ride request wait time for a first region of a geographical area and a second expected ride request wait time for a second region of the geographical area;
> identifying a first driving path from the location of the computing device to the first region and a second

> driving path from the location of the computing device to the second region;
>
> determining a first system inefficiency score for the computing device of the available driver based at least in part on the first expected ride request wait time for the first region and a first estimated driving time for the available driver to travel along the first driving path to the first region;
>
> determining a second system inefficiency score for the computing device of the available driver based at least in part on the second expected ride request wait time for the second region and a second estimated driving time for the available driver to travel along the second driving path to the second region;
>
> selecting a driving path for the available driver based at least on the lesser of the first system inefficiency score and the second system inefficiency score; and
>
> sending the driving path to the computing device of the available driver such that a system inefficiency score of a plurality of computing devices of a plurality of drivers is minimized upon the available driver following the driving path.

The Rejection

The Examiner rejected claims 1–8, 11–14, and 20–24 under 35 U.S.C. § 101 as directed to an abstract idea (Non-Final Act. 10–12).

The Examiner finds "the claims are directed to the abstract idea of 'determining an available driver based on a minimized system inefficiency'" (Ans. 4). The Examiner finds this abstract idea "is analogous to human mental work" (*id.*).

Appellant contends "the claims here are not directed to an abstract idea, but concrete limitations that improve on-demand transportation matching systems" (Appeal Br. 10).

Because we rely on new evidentiary references not cited by the Examiner, we will designate the rejection as a new ground of rejection in order to provide Appellant a fair opportunity to address these teachings and new position.

Principles of Law

An invention is patent-eligible if it claims a "new and useful process, machine, manufacture, or composition of matter." 35 U.S.C. § 101. However, the Supreme Court has long interpreted 35 U.S.C. § 101 to include implicit exceptions: "[l]aws of nature, natural phenomena, and abstract ideas" are not patentable. *See, e.g., Alice Corp. v. CLS Bank Int'l*, 573 U.S. 208, 216 (2014).

In determining whether a claim falls within an excluded category, we are guided by the Supreme Court's two-step framework, described in *Mayo* and *Alice*. *Id.* at 217–18 (citing *Mayo Collaborative Servs. v. Prometheus Labs., Inc.*, 566 U.S. 66, 75–77 (2012)). In accordance with that framework, we first determine what concept the claim is "directed to." *See Alice*, 573 U.S. at 219 ("On their face, the claims before us are drawn to the concept of intermediated settlement, *i.e.*, the use of a third party to mitigate settlement risk.").

Concepts determined to be abstract ideas, and therefore patent ineligible, include certain methods of organizing human activity, such as fundamental economic practices (*Alice*, 573 U.S. at 219–20; *Bilski*, 561 U.S. at 611) and mental processes (*Gottschalk v. Benson*, 409 U.S. 63, 67 (1972)). Concepts determined to be patent eligible include physical and chemical processes, such as "molding rubber products" (*Diamond v. Diehr*, 450 U.S. 175, 191 (1981)) or software "purporting to improve the functioning of the computer itself" (*Enfish, LLC v. Microsoft Corp*., 822 F.3d 1327, 1335 (Fed. Cir. 2016)).

If the claim is "directed to" an abstract idea, we turn to the second step of the *Alice* and *Mayo* framework, where "we must examine the elements of the claim to determine whether it contains an 'inventive concept' sufficient to 'transform' the claimed abstract idea into a patent-eligible application." *Alice*, 573 U.S. at 221 (quotation marks omitted). "A claim that recites an abstract idea must include 'additional features' to ensure 'that the [claim] is more than a drafting effort designed to monopolize the [abstract idea].'" *Id.* (alteration in original) (quoting *Mayo*, 566 U.S. at 77). "[M]erely requir[ing] generic computer implementation[] fail[s] to transform that abstract idea into a patent-eligible invention." *Id.*

The United States Patent and Trademark Office published revised guidance on the application of 35 U.S.C. § 101. USPTO's *2019 Revised Patent Subject Matter Eligibility Guidance* ("Revised Guidance").[3] Under the Guidance, in determining what concept the claim is "directed to," we first look to whether the claim recites:

> (1) any judicial exceptions, including certain groupings of abstract ideas (i.e., mathematical concepts, certain methods of organizing human activity such as a fundamental economic practice, or mental processes) (Guidance Step 2A, Prong 1); and
>
> (2) additional elements that integrate the judicial exception into a practical application (*see* MPEP §§ 2106.05(a)–(c), (e)–(h)) (Guidance Step 2A, Prong 2).

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[3] *2019 Revised Patent Subject Matter Eligibility Guidance*, 84 Fed. Reg. 50–57 (January 7, 2019).

Only if a claim (1) recites a judicial exception and (2) does not integrate that exception into a practical application, do we then look to whether the claim contains an "'inventive concept' sufficient to 'transform'" the claimed judicial exception into a patent-eligible application of the judicial exception. *Alice*, 573 U.S. at 221 (quoting *Mayo*, 566 U.S. at 82). In so doing, we thus consider whether the claim:

> (3) adds a specific limitation beyond the judicial exception that are not "well-understood, routine and conventional in the field" (*see* MPEP § 2106.05(d)); or
>
> (4) simply appends well-understood, routine, conventional activities previously known to the industry, specified at a high level of generality, to the judicial exception.

(Guidance Step 2B). *See* Guidance, 84 Fed. Reg. at 54–56.

Analysis

Applying the Revised Guidance to the facts on this record, we find that Appellant's claims 1–8, 11–14, and 20–24 are directed to patent-ineligible subject matter. Because the same issues are present in each of the claims, we focus our consideration on representative claim 1. The same analysis applied below to claim 1 also applies to the other rejected claims.

A. Guidance Step 2A, Prong 1

The Revised Guidance instructs us first to determine whether any judicial exception to patent eligibility is recited in the claim. The Revised Guidance identifies three judicially-excepted groupings identified by the courts as abstract ideas: (1) mathematical concepts, (2) certain methods of organizing human behavior such as fundamental economic practices, and (3) mental processes.

Claim 1 reasonably falls within two of the three of the judicially-excepted groupings listed in the Revised Guidance: mental processes and fundamental economic practices involving dispatching drivers to pick up riders.

It is well established that mental processes are abstract ideas. *CyberSource* instructs that "a method that can be performed by human thought alone is merely an abstract idea and is not patent-eligible under § 101." *CyberSource Corp. v. Retail Decisions, Inc.*, 654 F.3d 1366, 1373, 1375 (Fed. Cir. 2011) ("That purely mental processes can be unpatentable, even when performed by a computer, was precisely the holding of the Supreme Court in *Gottschalk v. Benson*.").

Similarly, the Federal Circuit has found automation of well-established methods of organizing human activity to be ineligible. *See, e.g.*, *In re Salwan*, 681 Fed. App'x 938, 941 (Fed. Cir. 2017) (finding automation of a method of organizing human activity with respect to medical information an abstract idea); *see also Intellectual Ventures I LLC v. Symantec Corp.*, 838 F.3d 1307, 1314–15 (Fed. Cir. 2016) ("it was long-prevalent practice for people receiving paper mail to look at an envelope and discard certain letters, without opening them, from sources from which they did not wish to receive mail based on characteristics of the mail" and noting that applying that well-known idea using generic computers was abstract).

Claim 1 performs both the mental process and method of organizing the human activity of taxicab dispatching. The taxicab dispatcher

> receives incoming telephone requests for taxis and relays the information on slips of paper to the radio operator. The radio dispatcher calls the vacant cab that is closest to the location of the pickup and records the information on a slip of paper of another color. Both slips are filed on a board which contains

> numbered receptacles corresponding to the cab numbers. These slips are a record of the position and status of every cab in the fleet.

(Vallarino[4] 233). The steps of determining the location of the driver and identifying wait times based on that location were steps necessarily performed by human dispatchers in selecting the vacant cab closest to the pickup of the customer (*id.*). Thus, these are mental steps as well as a well-established method of organizing human activity.

We find the instant claims similar to those in *Smart Systems*, where the Federal Circuit held that claims directed to a method for "validating entry into a first transit system using a bankcard terminal" did not satisfy *Alice* step one. *See Smart Sys. Innovations, LLC v. Chicago Transit Auth.*, 873 F.3d 1364, 1372 (Fed. Cir. 2017). *Smart Systems* found the claims were "not directed to a combined order of specific rules that improve any technological process, but rather invoke computers in the collection and arrangement of data. Claims with such character do not escape the abstract idea exception under Alice step one." *Id.* at 1372–3.

Similarly, the instant claims are directed to the use of a computer to determine the location of a driver and then determining the wait time of the rider based on the driving paths available and then select the most efficient route directions and send that route information to the driver (*see* Claim 1). Other than by use of a computer, this method does not substantively differ from the mental process of a taxicab dispatcher selecting the closest cab and

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[4] Vallarino et al., *Radio Dispatching System for Operation of a Large Taxicab Fleet*, https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6438006, 232–35 (1952).

telling the driver to take a different route in order avoid a traffic jam or accident. "[M]erely limiting the field of use of the abstract idea to a particular . . . environment does not render the claims any less abstract." *Affinity Labs of Tex., LLC v. DIRECTV, LLC,* 838 F.3d 1253, 1259 (Fed. Cir. 2016). Accordingly, we conclude that the steps of claim 1 recite judicial exceptions of mental processes and organizing human activities.

B. Guidance Step 2A, Prong 2

Having determined that the claims are directed to a judicial exception, the Revised Guidance directs us to next consider whether the claims integrate the judicial exception into a practical application. Guidance Step 2A, Prong 2. "[I]ntegration into a practical application" requires that the claim recite an additional element or a combination of elements, that when considered individually or in combination, "apply, rely on, or use the judicial exception in a manner that imposes a meaningful limit on the judicial exception, such that the claim is more than a drafting effort designed to monopolize the judicial exception." Guidance at 54.

A judicial exception is not integrated into a practical application when the claims are drawn to the mere use of "a computer as a tool to perform an abstract idea." Guidance, 84 Fed. Reg. at 55; *see Electric Power Grp., LLC v. Alstom S.A.*, 830 F.3d 1350, 1354 (Fed. Cir. 2016) (finding that "the focus of the claims is not on . . . an improvement in computers as tools, but on certain independently abstract ideas that use computers as tools"); *Enfish, LLC v. Microsoft Corp.*, 822 F.3d 1327, 1335–6 (Fed. Cir. 2016) (determining whether the claims at issue were focused on a "specific asserted improvement in computer capabilities" or "a process that qualifies as an 'abstract idea' for which computers are invoked merely as a tool").

Here, there is no integration into a practical application of the abstract idea. Other than the limitations directed to the abstract idea, discussed above, the invention is claimed at a very high level of generality and relies upon standard computing devices (*see* Spec. ¶ 21) and not "a particular machine . . . that is integral to the claim." *See* Revised Guidance, 84 Fed. Reg. at 55 n. 7.;

We appreciate that simply because standard devices are used is not solely dispositive of whether there is an integration into a practical application. However, we do not find integration under any analysis. In addition to using standard computer technology, the instant claims do not recite anything unconventional regarding the process of identifying driving paths (*see* Spec. ¶ 22, "processor 204 uses map information from map database 212 to plan routes"); determining wait times based on the driver locations and routes; or the calculated "system inefficiency score." We note that the Specification does not recite any specific algorithms for calculating a "system inefficiency score" but just provides the general concept of estimating the time taken by a driver to accept and pick up a passenger. *See* Spec. ¶ 19 ("[I]nefficiency score for a given driver comprises an estimate of the time until that driver is carrying a passenger, i.e., the sum of the estimated time until that driver receives and accepts a driver request and the estimated time for the driver to drive to the location of the request").

Thus, claim 1 does not recite elements that integrate the abstract idea into a practical application that is more than the abstract idea itself. Instead, the claims recite conventional computer components that are used to apply the mental process and organization of human activity of taxicab dispatching.

Appellant contends the "claims here are not directed to an abstract idea but a series of concrete elements for improving computing systems positioning computing devices of a plurality of drivers. Accordingly, the claims are analogous to the Federal Circuit's decision in *Enfish*" (Appeal Br. 11). Appellant contends that

> Similar to *Enfish*, the focus of the claims as a whole is not an abstract idea, but limitations that improve computer functionality and/or a technological process. As outlined in the Specification (and as recited in the claims), the claimed invention can significantly improve overall system inefficiency. For example, by efficiently positioning computing devices of available drivers, the claimed invention can reduce inefficiency in overall travel, travel time, driver wait times, and/or requester wait times.

(Appeal Br. 11).

We are unpersuaded by Appellant's reliance on *Enfish*, 822 F.3d at 1327. *Enfish* explains that "the first step in the Alice inquiry in this case asks whether the focus of the claims is on the specific asserted improvement in computer capabilities . . . or, instead, on a process that qualifies as an 'abstract idea' for which computers are invoked merely as a tool." *Enfish*, 822 F.3d at 1335–6. Applied to claim 1, the claimed software product does not provide for a technical improvement in a computer processor or in the electrical components of a driver dispatch system, but rather uses the computer as a tool to perform data analysis on driver location and availability data "for determining an ordering of drivers to deliver the request to in order to maximize system efficiency" (Spec. ¶ 18). That is, the current claims simply use the computer and software as tools to perform a mental process and process of organizing human activity as routinely performed by a taxicab dispatcher as discussed above. *See Elec. Power*

Grp., LLC v. Alstom S.A., 830 F.3d 1350, 1355 (Fed. Cir. 2016) ("[M]erely selecting information, by content or source, for collection, analysis, and display does nothing significant to differentiate a process from ordinary mental processes.") Appellant does not identify any teaching in the Specification that actually improves either the computer or the physical components of the dispatch system.

Appellant contends the "*Office Action* relies an over-generalized concept that is completely untethered from the actual claim language" (Appeal Br. 13). Appellant contends they "are not claiming an abstract idea, but specific limitations that improve functionality of computing systems" (Appeal Br. 14). Appellant contends "the claims expressly recite limitations for positioning computing devices of available drivers to improve overall system efficiency. In addition, the claims include numerous detailed steps for accomplishing these improvements and functions. *Electric Power Group* does not apply here" (Appeal Br. 15).

We do not agree that the Examiner over-generalized the abstract idea. Prior art evidences limitations of claim 1 that were known and routine prior to the submission of the instant application. Felt[5] teaches a taxi dispatch system comprising a network, a user device, a mobile taxi dispatch system, and one or more taxi devices (*see* Felt ¶ 15). Felt explains the taxi system "may include information about how far a particular taxi is located from the customer that is requesting the taxi. This information may be computed, for example, from information about the location of the customer making the request and from information about the current location of taxis" (Felt ¶ 61).

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[5] Felt et al., US 2011/0099040 A1, published Apr. 28, 2011.

Felt also teaches that selection may be "based on an estimated time it would take a taxi to reach the customer's location" (Felt ¶ 78).

Firantas[6] teaches the traditional taxicab dispatch system (Firantas 4) and teaches the "Unit should arrive to Object as soon as possible. In order to achieve that, Dispatcher has to evaluate time of arrival . . . and select the best match. We refer to 'route' as any of the possible routes and 'best route' as the best one of them" (Firantas 11). Firantas teaches the use of "real-time routing algorithms" that include traffic parameters and route configuration to identify the best route (*see* Firantas 11–12) and that the taxicab "should receive prepared routes from the server" (Firantas 13).

Thus, the evidence demonstrates that the only element of the claim that may not be expressly provided for in the prior art is the express requirement to use a mental process in organizing human activity of determining two routes, where Firantas may sometimes suggest only a single best route be identified and transmitted to the taxi (*see* Firantas 11–13).

We note that none of the detailed steps represent anything other than taking the abstract idea of determining an available driver based on a minimized system inefficiency and applying it using a computer system. *Alice* makes clear that "[s]tating an abstract idea while adding the words 'apply it with a computer' simply combines those two steps, with the same deficient result." *Alice*, 573 U.S. at 223.

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[6] Firantas et al., *Automated taxi request, dispatch, and routing:conceptual design*, http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.658.7373 &rep=rep1&type=pdf (2006). We number the pages sequentially from the first page.

Appellant contends that "[l]ike the patent eligible claims in *McRO*, the present claims reflect an approach to position computing devices of available drivers utilizing a sequence of unconventional steps" (Appeal Br. 18).

We find this argument unpersuasive. *McRO* was a computer based process that improves operations on the computer animation process itself, while claim 1 uses mental processes in the well-established method of organizing human activity of dispatching taxis by determining an available driver based on a minimized system inefficiency and sending the route information to the driver. *See McRO, Inc. v. Bandai Namco Games Am. Inc.*, 837 F.3d 1299 (Fed. Cir. 2016).

Unlike *McRO*, the computer in claim 1 is simply used as a tool to perform the same method performed in the mind of a taxicab dispatchers and drivers. That is, these humans identify the closest taxi, based upon factors including traffic and route accordingly (*see* Vallarino 233; Firantas 4 "Operator informs the customer about . . . estimated time of arrival . . . Driver plans his route of arrival"). The claim does not improve the computer itself. Claim 1 does not integrate the process steps into a practical improvement because the steps simply computerize known mental processes in a well-established method of organizing human activity. Therefore, contrary to *McRO*, where the ultimate product produced was a synchronized computer animation that was itself the transformative use, the result of the presently claimed method is a drawn to a method of taxicab dispatch and sending route information, which do not improve the computer itself.

Appellant also contends that "[l]ike *Bascom*, although the claimed invention may utilize known computer components, the ordered combination of elements utilized to position a plurality of computing devices in an improved manner comprises a concrete, inventive concept that is patent eligible" (Appeal Br. 20).

We are not persuaded by Appellant's arguments. In *Bascom*, the Federal Circuit found the patent claimed "a technology-based solution (not an abstract-idea-based solution implemented with generic technical components in a conventional way) to filter content on the Internet that overcomes existing problems with other Internet filtering systems." *Bascom Global Internet Serv., Inc. v. AT&T Mobility LLC*, 827 F.3d 1341, 1351 (Fed. Cir. 2016). Unlike *Bascom*, claim 1 recites an abstract-idea-based solution, i.e., a mental process for dispatching taxis and sending route information but does not indicate or identify any unconventional components or unconventional placement of components in the analysis, or indeed, any aspect that cannot be performed in the human mind.

While Appellant states that the "claims include a unique ordered combination of steps that improve the accuracy and efficiency of computing systems", we are not persuaded that the evidence of record supports this position because, as discussed above, the process is identical to that performed by an ordinary taxicab dispatcher and driver (Vallarino 233; Firantas 11–13; Felt ¶¶ 61, 78). Therefore, unlike *Bascom*, the invention at issue is not "a software-based invention that improves the performance of the computer system itself." 827 F.3d at 1351.

Appellant contends "[s]imilar to *DDR*, independent claim 1 of the present application addresses the computer and network-specific challenge of accurately and efficiently providing rides through a distributed, on-demand transportation matching system. Dynamic, on-demand transportation matching systems create new and unique problems for providing rides at a point of service" (Appeal Br. 20).

We are not persuaded that this fact pattern is similar to that in *DDR Holdings, LLC v. Hotels.com, L.P.*, 773 F.3d 1245, 1257 (Fed. Cir. 2014). *DDR Holdings* determined that the claims addressed the problem of retaining website visitors who, if adhering to the routine, conventional functioning of Internet hyperlink protocol, would be transported instantly away from a host's website after clicking on an advertisement and activating a hyperlink. *DDR Holdings*, 773 F.3d at 1257. The Federal Circuit, thus, held that the claims were directed to patent-eligible subject matter because they claim a solution "necessarily rooted in computer technology in order to overcome a problem specifically arising in the realm of computer networks." *Id.* The instant claim 1 does not identify a specific problem in the realm of computer networks, or indeed, in computer technology at all. Instead, claim 1 applies computer technology to the mental processes ordinarily used in a well-understood method of organizing human activity of taxicab dispatch and routing.

Instead, we find the claimed invention more akin to the claims in *Ultramercial, Inc. v. Hulu, LLC*, 772 F.3d 709, 714 (Fed. Cir. 2014) than those in *DDR Holdings*. In *Ultramercial*, like the instant case, the patentee argued that its claims were "directed to a specific method of advertising and content distribution that was previously unknown and never employed on the Internet before." *Ultramercial*, 772 F.3d at 714. However, *Ultramercial* found that the majority of the steps were directed to the abstract idea of offering media content in exchange for viewing an advertisement, and the "routine additional steps[,] such as updating an activity log, requiring a request from the consumer to view the ad, restrictions on public access, and use of the Internet[,]" and, as such, were insufficient to transform the patent-ineligible abstract idea into patent-eligible subject matter. *Id*. at 715–16.

Here, while the claims recite a specific abstract idea implemented in software, that software does not alter the computer itself, but rather falls into the category of methods "that can be performed by human thought alone . . . and is not patent-eligible under § 101." *CyberSource Corp. v. Retail Decisions, Inc*., 654 F.3d 1366, 1373, 1375 (Fed. Cir. 2011) ("That purely mental processes can be unpatentable, even when performed by a computer, was precisely the holding of the Supreme Court in *Gottschalk v. Benson*.").

Therefore, on this record, we conclude that the ineligible subject matter in Appellant's claim 11 is not integrated into a practical application.

C. Guidance Step 2B

Having determined that the judicial exception is not integrated into a practical application, the Revised Guidance requires us to evaluate the additional elements individually and in combination to determine whether they provide an inventive concept, such as a specific limitation beyond the judicial exception that is not well-understood, routine, conventional in the field, or simply appends well-understood, routine, conventional activities previously known to the industry, specified at a high level of generality, to the judicial exception. *See* 84 Fed. Reg. 51.

Appellant contends "in light of the Federal Circuit's decision in *Berkheimer v. HP Inc*., 881 F.3d 1360 (Fed. Cir. 2018), Examiners must expressly support a finding that additional elements are well-understood, routine or conventional" (Appeal Br. 17).

We agree with Appellant that *Berkheimer* mandates evidence showing the claim elements were well-understood, routine, and conventional in the prior art is necessary to satisfy Alice step two. The Examiner does provide evidence demonstrating that the structural components of the claim were recognized by the Specification including the computing device and processor are well-understood, routine, conventional in the field (*see* Ans. 5, Spec. ¶¶ 15, 21). The Examiner does not provide evidence that taxicab dispatch or identifying optimal routes was known in the prior art. However, as discussed above, Vallarino, Firantas, and Felt all teach taxicab dispatch based on the location of the rider and taxicab was well known (Vallarino 233; Firantas 11–13; Felt ¶¶ 61, 78). Moreover, Firantas teaches that computerized route selection was known, and indeed suggests that a server determine that route information and send it to the taxicab (Firantas 13).[7]

We, therefore, find that Appellant's claims do not require anything other than the use of conventional and well-understood techniques and equipment to dispatch a taxi using the mental process of determining an available driver based on a minimized system inefficiency according to the recited judicial exception. The addition of this mental process cannot supply the requisite inventive concept. *BSG Tech LLC v. BuySeasons, Inc.*, 899 F.3d 1281, 1290 (Fed. Cir. 2018) ("It has been clear since *Alice* that a claimed invention's use of the ineligible concept to which it is directed cannot supply the inventive concept that renders the invention 'significantly more' than that ineligible concept."). Accordingly, the preponderance of

[7] We note, but do not rely, on the fact that Google Maps was publicly available in February 2005 (*see* https://www.theguardian.com/technology/2015/feb/08/google-maps-10-anniversary-iphone-android-street-view).

evidence of record supports the Examiner's finding that Appellant's claimed invention is directed to patent-ineligible subject matter. The rejection of the claims under 35 U.S.C. § 101 is affirmed.

CONCLUSION

In summary:

Claims Rejected	**35 U.S.C. §**	**Reference(s)**	**Affirmed**	**Reversed**	**New Ground**
1–8, 11–14, 20–24	101	Eligibility	1–8, 11–14, 20–24		
1–8, 11–14, 20–24	101	Eligibility			1–8, 11–14, 20–24
Overall Outcome			1–8, 11–14, 20–24		1–8, 11–14, 20–24

We designate our affirmance as a ground of rejection pursuant to 37 C.F.R. § 41.50(b) because of the newly cited references. Section 41.50(b) provides "[a] new ground of rejection pursuant to this paragraph shall not be considered final for judicial review." Section 41.50(b) also provides:

> When the Board enters such a non-final decision, the appellant, within two months from the date of the decision, must exercise one of the following two options with respect to the new ground of rejection to avoid termination of the appeal as to the rejected claims:
>
> (1) Reopen prosecution. Submit an appropriate amendment of the claims so rejected or new Evidence relating to the claims so rejected, or both, and have the matter reconsidered by the examiner, in which event the prosecution will be remanded to the examiner. The new ground of rejection is binding upon the examiner unless an amendment or new

> Evidence not previously of Record is made which, in the opinion of the examiner, overcomes the new ground of rejection designated in the decision. Should the examiner reject the claims, appellant may again appeal to the Board pursuant to this subpart.
>
> (2) Request rehearing. Request that the proceeding be reheard under § 41.52 by the Board upon the same Record. The request for rehearing must address any new ground of rejection and state with particularity the points believed to have been misapprehended or overlooked in entering the new ground of rejection and also state all other grounds upon which rehearing is sought.

Further guidance on responding to a new ground of rejection can be found in the Manual of Patent Examining Procedure § 1214.01.

AFFIRMED; 37 C.F.R. § 41.50(b)

Notice of References Cited	Application/Control No. 13/828,952	Applicant(s)/Patent Under Reexamination	
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U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
	A	US-				
	B	US-				
	C	US-				
	D	US-				
	E	US-				
	F	US-				
	G	US-				
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FOREIGN PATENT DOCUMENTS

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	U	Firantas et al., Automated taxi request, dispatch, and routing:conceptual design, http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.658.7373 &rep=rep1&type=pdf (2006).
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Automated taxi request, dispatch, and routing: conceptual design

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Abstract

Design options are analyzed and conceptual design is proposed for automation of taxi dispatch and routing processes. Location-based services and context-awareness have been employed for that purpose.

Introduction

Digital dispatch and routing is blooming during the last 10 or 15 years. This kind of approach is way superior compared to formerly used voice dispatch and manual routing.

We would like to go further in this direction by proposing and conceptually designing "state of the art" taxi dispatch-routing application.

The application should provide functionality of the 2 current dispatch-routing approaches (described later) and offer substantial beneficial improvements. It should use the latest achievements of location-based and context-aware technologies while staying feasible. The exact sub-goals are stated later.

Ideally, the application should automate the process and require no human intervention during dispatch and/or routing.

Economical aspects are outside the scope of this project, but we try keep cost in mind and apply consumer electronics if possible. We assume that the application is a "fresh start", i. e. there is no (pre-installed) infrastructure or technology that it should reuse, or adhere to.

First we define our application area precisely and review some background for it. Later we analyze the application design options, and finally make our choices for the conceptual design.

Key terms used:

- Geographic Information (System) (GIS)
- Traffic Information (System) (TIS)
- Advanced vehicle location (AVL)
- Computer-Aided Dispatch (CAD)
- Mobile Data Terminal (MDT)
- Interactive Voice Recognition (IVR)
- Global Positioning System (GPS)

- Global System for Mobile Communications (GSM)

Application area

The application area of this study are the request, dispatch and routing (route planning) processes of a taxi service.

To define the application area more specifically, we have several key assumptions that we focus on:

- business

  As opposed to public (city- or government-operated) services.

- passengers
- cars
- urban environment
- floating routes

  As opposed to fixed routes of public transport.

- "livery car" approach

  Livery car (in American-English) means a type of taxi that is requested and dispatched remotely, as opposed to picking up passengers on the street like medallion taxicabs do. In some jurisdictions same taxis work both ways, while in others this distinction is explicit [1][2].

- real-time service request (i. e. booking)

  As opposed to booking in advance.

However, we think that many points of the study also apply to different areas that involve processes of our interest.

Background

Today, many different real-time taxi dispatch and routing scenarios are used around the world. They differ in complexity, use of (modern) technologies, and improvements they bring. We tried to group them into 2 main approaches that are as isolated as possible. Still, it is very likely that the real world application uses a mix of both.

We described the approaches in terms of actors and activities. We focused on dispatch and routing perspective and left out irrelevant or over-detailed activities such as calling, talking, driving, paying etc. Here we define only a "successful" process, and make some assumptions about failures later.

Voice dispatch and "mental" routing

For years this has been the only way of dispatch, and in many areas it still is the main one. According to our empirical experiences and different sources, voice dispatch process may have many variations, but the main activities are as follows:

1. Customer contacts the Dispatch center via phone (stationary or mobile)
2. Call is handled by a human Operator (sometimes called call-taker)

   He or she enters Object details into the (manual or computer) system. In case a computer system is used, we assume it is not a full CAD (see Data dispatch) system and therefore.
3. Dispatcher broadcasts detailed request to all operating Drivers via radio channel

   An Operator may also be a Dispatcher.
4. Every Driver himself estimates time of arrival to the Object and responds to the Dispatcher
5. Dispatcher assigns the task to the best-matching Driver
6. Operator informs the Customer about service availability, estimated time of arrival and/or Vehicle details

All actors communicate verbally.

Routing is a separate process:

1. Driver plans his route of arrival to the Object

   Generally, routing is not coordinated with the Dispatch center and is a manual (or, more precisely, "mental") process. The Driver can only rely on Object location and his own knowledge (of the area, traffic congestion patterns etc.)
2. Driver plans his route of transportation of the Object

   Likewise, he Driver can only rely on destination location and own knowledge

Digital dispatch-routing

Taxi companies started to adopt this form of dispatch in the 1990s following the rapid development of mobile communication and tracking technologies [3] [4] [5] [6] [7].

Using digital approach, dispatch is virtually inseparable from routing.

This form of dispatch:

1. Object contacts the Dispatch center via phone (stationary or mobile)
2. Call is handled by a human Operator which enters Object details into CAD
3. CAD selects the best-matching Vehicle

   AVL and possibly TIS are employed.
4. CAD assigns the task to selected Vehicle
5. Order details are transferred to Vehicle's MDT
6. CAD or MDT plans route of arrival to the Object
7. CAD or MDT plans route of transportation of the Object

Scenario

Here we come up with a single formalized scenario with actors, activities, their criteria, and some more detailed assumptions.

We tend to merge dispatch and routing into a single process (dispatch-routing) and try to describe it in terms of actors and activities, according to current approaches.

To remain brief, we introduce some generalization if the same points apply to actors or activities despite of their physical nature. They have to suit current approaches as well as our intended design.

Actors

All the actors are crucial and interconnected – the process does not take place when any of them is missing.

Actors:

1. Object

   An entity to be transported by the Unit. It may or may not be the same entity that has requested the service from the Dispatcher.

   A number of Object instances may be involved in the process at any time. This actor is not controllable by the application.
2. Unit

   An entity that follows Dispatcher's orders and provides transportation of Object.

Unit combines activities of Driver, Vehicle, and MDT. A number of Unit instances may be involved in the process at any time.

It is a controllable actor.

3. Dispatcher

   An entity that links Objects to Units: accepts Object requests and dispatches/routes Units accordingly. Combines activities of Operator, Dispatcher, and/or the CAD. We assume, that only one Dispatcher takes part in the process at all times.

Activities

Inter-actor activities:

1. Communication

   2-way communication between actors

2. Positioning

   Of Object and Unit

3. Routing

   Route generation and evaluation based on context and location. It has to be coordinated with a number of Unit actors in mind.

   We assume that the same activity is used for both Unit routes to Object and to it's destination.

Outline

This is an outline of the process scenario with our definitions:

> *"Transportation service for Object is requested by communicating to the Dispatcher. Dispatcher dispatches and routes Units in such manner that one arrives to Object as soon as possible. That Unit is then routed to provide the fastest possible service for Object."*

Criteria

The dispatch-routing process may be evaluated according to these criteria [8]:

1. Availability

   Percentage of Object requests that were confirmed by Dispatcher.

   Availability does not indicate reliability.

2. Reliability

   Percentage of Units that actually reach the Object that they are dispatched to.

   Reliability indicates availability.

3. Duration

   The process of our interest is time-critical. We assume, that it should take place in real-time.

4. Distance

   Of Units route(s)

Design options

Issues, goals, and impact

There are several issues in the application area [8]. They descend directly from the criteria:

- low availability
- low reliability
- long distance

Our application should focus on current issues and therefore try to:

- decrease
  - time to serve a Object
  - fuel consumption
  - empty cruising time
- increase
  - number of Objects served
  - taxi availability
  - variety of request (communication) methods
  - precision of positioning and routing

As we can see, the goals are highly interrelated. Moreover, they are tightly coupled with the activities of the actors.

Th desired impact on the actor basis:

- Object

Decreased waiting/travel time, increased availability/reliability, more booking options

- Dispatcher

  Elimination of human Operators and Dispatchers

- Unit

The whole application should also be cost-effective.

Communication

Here we analyze ways of Object-Dispatcher and Dispatcher-Unit communication. We decompose communication in terms of protocol and underlying media. It is not a physical but rather a logical decomposition (e. g. the Internet is usually provided using the phone network).

Media:

- dedicated radio channel

  It is the traditional communication link between Dispatcher and Unit. A special license is necessary in order to operate it. However, providers of radio service on the subscription basis exist [9].

  Dedicated radio receivers are usually built into MDTs that are used in Units.

- phone network

  - stationary
  - mobile

  In current approaches it is used for communication between Object and Unit.

  Mobile phone network is based on GSM. a wireless communication technology. GSM network is cellular; cells are areas covered by base stations. Mobile devices connect to a base station and fall in one of the cells. From a user's infrastructure-transparent point of view, GSM enables long-range communication for mobile devices.

  Recent mobile devices ("smartphones") have a standard operating system (Symbian OS, Windows Mobile) with extensive programming capabilities, relatively large displays and memory.

Protocol [10]:

- voice

In common approaches voice is used for conversation between Object and Dispatcher. If the Dispatcher is automated (Operator-less), to design which is our goal, using voice is only possible with an IVR system.

- data

  It is used by digital dispatch systems like AVL

Here are some parameters that can be obtained in the communication activity:

- Object location

  Since our goal is to automate the dispatching, the only option to keep letting the Customers use voice request is to employ an IVR system

- Object identity

  Different customers may be given different priority, different fares etc.

- required Unit configuration

  A Object may have special requirements for the Unit that is to arrive. For example, he may require a larger Vehicle (with more seats or luggage space) than a standard one; a Vehicle with support for handicapped etc.

  We assume that in most cases no special requirements are provided. Therefore there should be a default (standard) Unit configuration defined.

- request time

  Time and/or date when the service is required, if the booking is in advance.

Communication has to be used not only for sending or receiving requests but also in critical situations, for example:

- if Unit declines the task or is not able to fulfill it
- there is no Object at the pick-up address

Positioning

Object and Unit locations are the basis of all routes and have to be known at the time of route evaluation (which options are described later). Actor mobility is a key issue in this activity.

Object location may be explicitly included in booking details (e. g. if the booking is in advance) or obtained in communication activity (e. g. using IVR system). In this situation, the Object will most likely provide geographical, semantic (e. g. “IT University of Copenhagen”) location rather than physical coordinates, and the application has to be able to convert between them. It might even deal with temporary and time-relative locations, e. g. “the U2 concert venue for this evening”.

We think that the scope of location should be global because of the large of urban environment and no practical use of relative locations in the application area.

If location is not explicitly provided, it has to be found using a positioning technology. Since Object actor is not controlled, therefore we cannot expect it to have any other kind of device than the one that was used for communication.

If the fixed phone network was used for communication, it might be possible to obtain location (of certain degree of accuracy) using telecom's data. However, this approach has many issues (privacy being one of the most obvious) and we found no signs of it's practical use. In such case the application should fall-back to determining Object location via communication.

GSM is not particularly well suited for positioning since positioning is only an outcome of it's communication capabilities. However, several techniques exist, including cell identification and signal lateration. In modern mobile devices, positioning information may be available via an API (Java Location API) if there is a provider's support for this feature. Location may be calculated on the base or on the phone. Signal availability is not a big issue in GSM (and hence GSM-based positioning) compared to GPS.

Unit location is also subject to change over time, and has to be tracked in real-time using an AVL system. Since Unit is controllable, there a no obstacles to install required hardware or software on it.

GPS is the most widespread positioning technology. A receiver device is able to calculate it's own position using triangulation of satellite signals that it captures.
Accuracy of the basic system is within the range of 10s of meters, but with extensions as DGPS it is believed to increase to 1-3 meters. Satellite signal availability is crucial for GPS positioning. That may be an issue in an urban environment as ours, where buildings may block satellites from line of sight of the receiver. However, recent receivers perform quite well in that situation.

GPS was developed by USA for military use and was available to civilian users with intentionally decreased accuracy (“selective availability”). Recently this restriction has been removed.
EU has launched it's own independent (but nevertheless GPS-compatible) satellite positioning system Galileo, indented primarily for civilian use.

Receivers differ in size, energy consumption, cost. There are standalone GPS receivers as well as those integrated into MDTs, PDAs, mobile phones etc.

Routing

Unit should arrive to Object as soon as possible. In order to achieve that, Dispatcher has to evaluate time of arrival of an array of Units with respect to that Object and select the best match.

We refer to “route” as any of the possible routes and “best route” as the best one of them (the result of evaluation).

Obviously, route is generally different from a line connecting locations, since Unit moves in an urban environment and has to adhere the fixed road network. Instead, evaluation should employ representation of the road network and well-explored real-time routing algorithms (their variations and implementations are not discussed here). This kind of evaluation is a an application of the shortest weighted path search algorithm. However, different routing techniques also exist, e. g. neural networks-based (a technique for computer network traffic is described in [11]).

A trivial solution is to assume that route length is proportional to it's duration (i. e. average Unit speed is constant) and hence can also be used as it's metric. Route length may be calculated using GIS with the necessary map data.

However, there is an array of contextual parameters that influence Unit speed and route duration and might be taken into account during evaluation:

- traffic parameters

  Traffic congestion may severely limit Unit speed on the route and dramatically increase it's duration. Obstacles like road works or incidents may block the route completely and eliminate it from evaluation.
  Traffic status could be retrieved from a real-time TIS, which may be operated by humans as well as sensors. The other option is to have a digital traffic model, or a combination of both for more accuracy.

- route configuration

  Speed limits, traffic lights, pedestrian crossings, turns and similar artifacts may also limit Unit speed and increase route duration. Geographical and geometrical data of these objects could be obtained from a special GIS, which may be coupled with a local traffic control system, if there is one.

- area

  In some areas, Unit is only allowed to operate in certain explicitly defined zones. While this is not a matter of routing, different areas (e. g. a route that goes out of city boundaries) are also subject to different service fares.

- fuel consumption

  It is something to avoid, and even routes of the same length may require different amount of fuel for a Unit. A route with long constant speed segments is likely to require less fuel than the one with frequent stops and run-ups.

- fairness

  Every Unit should receive a more or less equal amount of work.

- request patterns

  Request data might be collected, analyzed and used for route optimization. If there is no task for a Unit at a given time, it should be routed to a location where usually a high number of requests originates (e. g. city center or a transit station).

- time

  In order to deal with bookings in advance, the application should be aware of the booking schedule and integrate it with real-time requests. Different time periods might also be subject to different service fares.

Only Unit that matches certain criteria should be subject to evaluation:

- configuration

  It has to match Object's requirements (number of seats etc., that should be specified in the request details)

- status

  Unit may also have different status: ready for orders, on route to Object, on route to destination. if Vehicle has broken down or Driver has health problems. In such case it does not participate in the process. The routing algorithm has not exclude a Unit that is on route at a given moment. In some situations, e. g. if it's current destination location is close to the location of a next Object to be served, that Unit is likely to be the best-match.

Conceptual design

The application tends to automate activities of Dispatcher. From the Unit and Object point of view, we suggest no obvious changes compared to digital dispatch-routing that we have reviewed for background.

We think that the application can be implemented in a communication-independent way. That would let easily increase the variety of service booking options and allow the use Internet or SMS besides the traditional voice requests.

Routing is where most of the location-based and context-awareness points apply. It has to use a sophisticated algorithm with several location concepts and context parameters. However, not all of them are critical for taxi routing. For example, taking route configuration into account would be an overkill for the application. It is also likely that this feature would not pay off economically.

System architecture

System hardware and software should be distributed across Dispatcher and a number of Unit instances. There is no way to install any of that on the Object side, since it is an uncontrolled actor.

We think that Unit should function as client, and Dispatcher as a server. That results in a client-server architecture.

In terms of application logic, the client should be rather thin. It has to have communication and user interaction capabilities. While it may have capabilities to calculate routes to some extent, only the server is able to collect the data of all contextual parameters from the relevant systems (AVL, GIS, TIS) and provide precise routing. Therefore the client should receive prepared routes from the server.

The client should employ "pull" strategy and send requests to the server in time intervals. We think this is easily implemented in the webservice manner.

We would use mobile smartphones as the client (Unit) side hardware. They have no less features than proprietary MDTs: extensive communication, positioning and programming capabilities and large color displays, sufficient for user interaction. Moreover, smartphones are relatively cheap and widely available.

Conclusions

We investigated the possibilities of automation in the dispatch-routing process. Many issues of the application area may be solved by eliminating the human intervention in the Dispatcher role. For example, duration and cost of service may be cut-down using context-aware routing, and service accessibility increased using several booking options.

We also argue that mobile smartphones are unique devices for innovative design of a dispatch-routing application.

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the fault on the system is cleared and the synchronous machines of the interconnected system are in the process of swinging.

With the relatively high internal electromotive force established during the pretransient conditions as a function of terminal voltage, kilovolt-ampere load, and machine reactance, an instantaneous change in the reactive output of the machine can be accomplished by changing suddenly its equivalent reactance. This change can be effected by inserting between terminals of the machine and the bus a certain amount of series capacitors normally short-circuited by a circuit breaker which opens for a short time when the increased kilovolt-ampere output is required and then closes again.

The circuit breaker should not open during the fault but right after the fault is cleared and the system is in the process of swinging. Therefore, the circuit breaker does not have to be faster than about 4 cycles and should reclose in about 2 seconds. Both of these times should be adjustable.

The value of reactance of these series capacitors is determined by the permissible degree of compensation, that is, equal to or somewhat less than subtransient reactance but definitely less than transient reactance. The current carrying capacity or the voltage across the capacitors may be at least twice rated value because these capacitors will be in the circuit for only about 2 seconds.

It is believed that this method of decreasing the reactance of the synchronous condensers during the short time that it is necessary is just as effective and more economical than building low-reactance machines. The cost of static capacitors per kilovolt-ampere is slightly less than half the cost of synchronous condensers and, in addition, since the series capacitors in this application are in the circuit only about 2 seconds, they can be operated at currents and voltages at least twice normal on capacitors that are tested at double voltage for one minute.

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Radio Dispatching System for Operation of a Large Taxicab Fleet

A. R. VALLARINO S. W. LEWINTER

The dispatching of taxicabs by radio has proved to be practical and economical but due to the shortage of radio-frequency channels assigned to this service by the FCC interference difficulties have been experienced. Solutions to this problem are offered by means of frequency and space allocations.

THE SHORTAGE OF radio-frequency channels has been one of the major impediments to use of radio dispatching in large taxicab fleet operations. There is an upper limit to the number of taxicabs that can be handled as a group on one radio-frequency channel. The exact number depends on the type of control used in the system.

To use radio successfully for a large taxicab fleet, the communication load must be divided into noninterfering groups. If the division is attempted by assignment of separate frequencies to each group, then the number of frequencies required usually exceeds the number presently assigned to taxicab radio service by the Federal Communications Commission (FCC). Methods of dividing the communication load of a single radio-frequency channel on a geographic basis by means of directional antennas are known. These are never entirely satisfactory since the directivity patterns that can be obtained are never sharp or stable enough, and interference in boundary regions is inevitable. Moreover, reflections from neighboring objects aggravate this interference.

This article develops methods of frequency and space allocations whereby a taxicab fleet of any size can be served by an interference-free radio system using not more than four radio-frequency channels. In most cases, only three channels are required and in many cases two are

Full text of paper 52-67, "A Radio Dispatching System for Large Taxicab Fleet Operation," recommended by the AIEE Committee on Special Communications Applications and approved by the AIEE Technical Program Committee for presentation at the AIEE Winter General Meeting, New York, N. Y., January 21–25, 1952. Not scheduled for publication in AIEE *Transactions*.

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adequate. These solutions are practical from both technical and economic considerations. It is believed that the methods described are of fundamental importance and of sufficient generality to be of value in dealing with communication problems of any large taxicab company.

Four practical solutions requiring either two or three radio-frequency channels and combining geographic and frequency subdivision of the communication load are described. The particular solution that would be most appropriate will depend on local conditions.

Each mobile equipment is designed for the number of frequencies required by the system so that the driver can select any one of them by means of a switch. The city is divided into areas that are so arranged that no interference zones exist when each area is assigned the proper frequency. See Figures 1 and 2. Each area contains a base-station transmitter and receiver with their antennas. Land-lines connect these stations to the main dispatching office. Whenever a driver crosses an area boundary, he switches to the correct channel for the new area. As many radio dispatchers as there are areas can be used during busy periods. The force can be contracted during slow periods by combining the operation of several areas under one dispatcher.

As examples of the potential opportunity for radio in the taxicab field, there are the 600 fleet cabs in Pittsburgh, 2,000 fleet taxicabs in Philadelphia, approximately 13,000 fleet taxicabs in New York City, and about 50,000 fleet taxicabs in the country.

LIMITATIONS OF PRESENT RADIO DISPATCHING SYSTEMS

A study was initiated about a year ago to determine whether we could propose for the large taxicab fleet operators a radio dispatching system using the limited number of radio-frequency channels allocated to the taxicab service by the FCC. It was intended that the study should bring out clearly the differences between the communication problems of the small taxicab operators now using radio dispatching and the largest taxicab fleets not so doing at the time the study was begun. The results

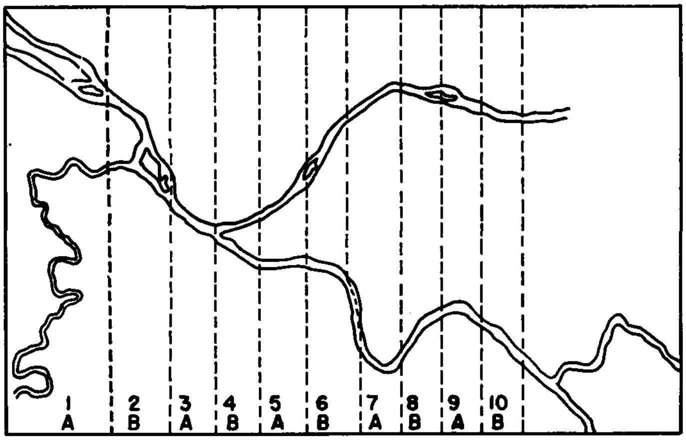

Figure 2. Division of area of Figure 1 for operation with two radio-frequency channels which are lettered and the sectors numbered

were expected to prove of assistance in the design of radio dispatching and control systems for the largest taxicab fleets.

At the present time, radio is used mostly by taxicab companies having fleets of fewer than 125 cabs. Beyond this point, the difficulties of dispatching cabs by radio multiply rapidly. The technical problems posed by these larger operations center about the dispatcher's capacity to retain large amounts of continually changing information and the shortage of radio-frequency channel space allocated by the FCC to the taxicab industry.

A description of the operating methods of a typical small radio-controlled taxicab fleet will show why it is not possible to extrapolate directly to obtain operating procedures for the largest fleet operators. This company operates a fleet of 50 radio-controlled cabs. The dispatching is handled by two operators using a single radio-frequency channel. One of them receives incoming telephone requests for taxis and relays the information on slips of paper to the radio operator. The radio dispatcher calls the vacant cab that is closest to the location of the pickup and records the information on a slip of paper of another color. Both slips are filed on a board which contains numbered receptacles corresponding to the cab numbers. These slips are a record of the position and status of every cab in the fleet. The number of cabs that can be handled with this system is limited by the ability of the dispatcher to avoid a nervous breakdown on rainy days when everyone wants a cab. Either human or channel load capacity or a combination of both will limit the extension of such a system to fleets of several hundred cabs.

A radio communication system to meet the needs of a metropolitan cab company of 350 cabs will be outlined. The experience of several taxicab operators using radio systems in which the detailed movements of the fleet are controlled will be used in planning the proposed system. Under normal traffic conditions, one unassisted dispatcher is capable of controlling a maximum of about 70 cabs; at the busiest times, this number shrinks to about 35 cabs. If the dispatchers work independently, each assigned to a sector having approximately the same number of cabs, ten dispatchers and ten channels will be required to handle

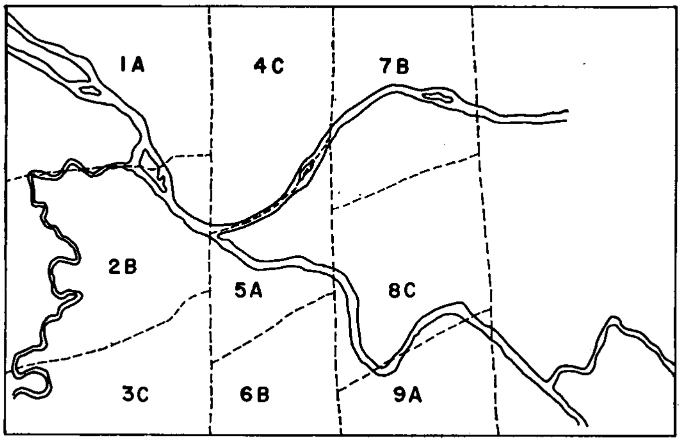

Figure 1. Division of an area for operation with three radio-frequency channels. The sectors are numbered and the channels are lettered

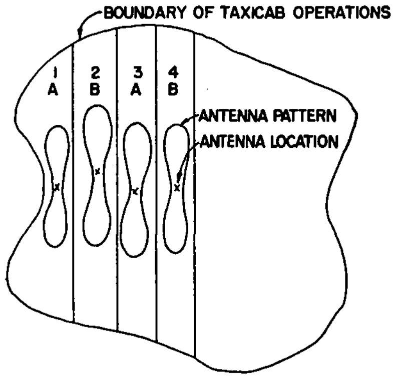

Figure 3. Trapezoidal pattern of space with numbered sectors and frequency allocations, which are lettered, using two radio-frequency channels

peak loads. The term "channel" as used here does not necessarily mean ten 2-way frequencies. A channel is any device by which calls from base stations to mobile units and mobile units to base stations can be segregated into mutually noninterfering groups. In considering the general problem of radio dispatching to taxicabs, channels can be obtained either by frequency or space allocation, the latter to be accomplished by directive antennas. Combinations of the two methods are often the most practical solutions to the channel problem. In any of these methods, ten channels require ten base-station installations.

DESIGN OF INTERFERENCE-FREE SYSTEM

THE RADIO COMMUNICATION load for the given example must be divided into ten approximately equal parts to permit the handling of the necessary volume of messages. One way of accomplishing this is to use frequency allocation and to transmit over the entire city from ten base stations on ten radio frequencies and have one-tenth the cabs receive a given frequency. To divide the incoming messages, ten cab transmitting frequencies are needed with ten receivers used at the base station. In calling a given cab the dispatcher must transmit at the frequency to which the receiver in that cab is tuned and he must expect an answer from the proper base-station receiver. This method is impractical since it requires ten duplex channels, more than the total number presently assigned to the taxicab radio service by the FCC.

The other extreme in dividing the communication load is space allocation. One duplex channel is used with the city divided into ten areas in which the volume of cab business is approximately equal. By the use of selected transmitting sites and directional antennas, an attempt is made to restrict the coverage of each base station to the assigned area. The same antennas are used to receive the taxicab transmissions. By this means and also by restricting the power radiated by the cabs to as small a value as is consistent with reliable operation, the messages from the cabs are divided into ten groups. This method always results in a certain amount of interference in the boundary zones between areas. The directive patterns of the antennas cannot be made sharp enough to prevent overlap; moreover, there are reflections from buildings and other topographical features that produce interference zones.

A combination of frequency and space allocation can result in a system which is efficient in the use of radio-frequency channels and yet does not create zones in which the transmissions from the various areas interfere with each other. The region served by the taxicab company is divided into ten areas. Each area has a base-station transmitter with antenna pattern and power adjusted to confine the radiation into that area plus a small amount of overlap into adjacent areas. The base stations in adjacent areas transmit on different frequencies and these stations are also designed to cover their areas plus some overlap. A mobile receiver in the boundary zone between adjacent areas can receive either base station, but they will be received on different frequencies. The cab receiver and transmitter must be designed for multichannel operation so that the driver merely throws a switch the moment he crosses the boundary line.

Each base station also contains a receiver that is tuned to the channel used by the taxicab transmitters when they are in that area. The base receivers are connected to the same antennas as the base transmitters through an antenna relay, or they are connected permanently to separate antennas having the same directive properties.

The boundaries between areas are marked off on a map and the drivers can be required to memorize the boundary locations. A driver crossing an area boundary would notify his dispatcher and then switch over to his new frequency. The dispatcher then would transfer his number to the dispatcher for the new area.

ALLOCATION PATTERNS

THERE REMAINS THE problem of setting up the ten areas and determining how many frequency channels are required. The frequencies used by the base stations in any two areas having a common boundary must be different. The area boundaries are to be drawn in such a way that the number of frequencies required is at a minimum.

This problem is very similar to the classical map problem in topology. The map makers wanted to know how many colors at most were needed to contrast adjacent countries in a mythical continent. The continent was to be of an arbitrary shape and the subdivision into countries was to be performed in any desired manner. The answer is that no more than four colors are ever required, no matter how complicated the map. If the four colors are used properly, no two countries having a common boundary will be shown with the same color.

The solution to this problem tells us that no more than four frequencies are ever needed if we divide the city into areas of any desired size and shape. Perhaps four fre-

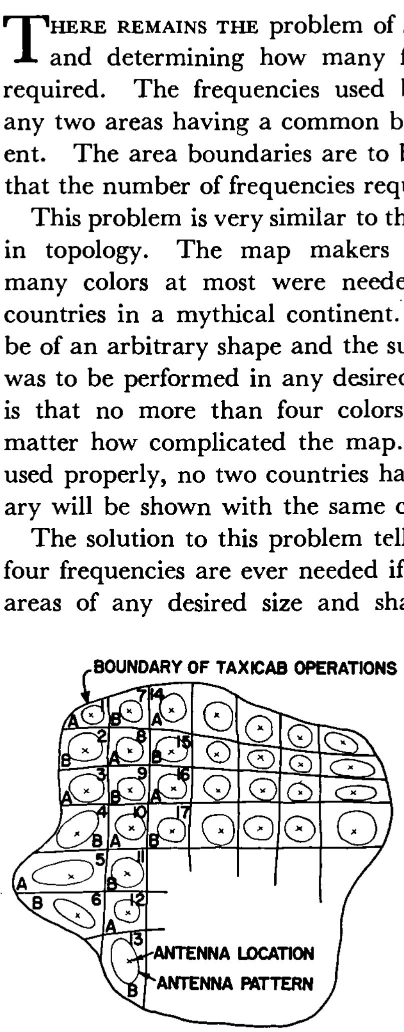

Figure 4. Modified rectangular pattern of space and frequency allocations using two radio-frequency channels, which are lettered

quencies is the answer to very large cities like New York and Chicago if a taxicab operator of a major fleet wishes to provide a radio call service over the entire region. However, in most situations only two or three frequencies are needed if the geometric layout of the areas is properly made. There are two basic patterns employing two frequencies. In one pattern the city is divided into a series of trapezoidal strips with alternate strips using the same frequency, Figure 3. The base stations are located at the approximate center of each strip. The second 2-frequency pattern is the modified rectangular grid of Figure 4. Adjacent boxes use different frequencies. Some interference can be expected in corner regions since the fields must overlap to some extent. Nevertheless, it may be possible sometimes to use this kind of pattern by varying the size and shape of the boxes so that the corners are placed at natural barriers. Figure 4 shows how this can be done.

Where corner interference cannot be tolerated, the 3-frequency pattern of Figure 5 may be used. The basic pattern resembles an arrangement of bricks in a wall but this can be modified as is shown in the figure.

A second 3-frequency method is shown in Figure 6. Here the pattern resembles the spokes of a wheel with alternate sectors being assigned the same frequencies, and the hub assigned the third frequency.

Four basic patterns of areas and frequency allocation have been presented. In designing a radio dispatching system for a specific case, the choice from among the four patterns will be determined by local factors. Some of these are:

1. Street layout and traffic flow pattern.
2. Topography, including hills, cliffs, tall buildings, and open spaces such as rivers and parks.
3. Availability of base-station sites.
4. Number of radio-frequency channels available.
5. Comparative costs.

As an example of the advantages and disadvantages of a particular pattern, consider the radial pattern with the central hub. A centralized location for the base stations and antennas is required. This raises certain technical problems. The distances to be covered along the radii are much greater than the distances in a plan using decentralized base stations. Dead spots and distortion of the sector shapes by reflections from cliffs and tall buildings must be avoided. Care must be taken to minimize the

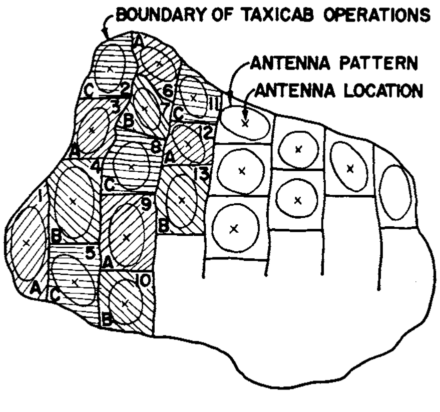

Figure 5. Three-frequency pattern based on rectangular partitioning in which the sectors are numbered and the channels are lettered

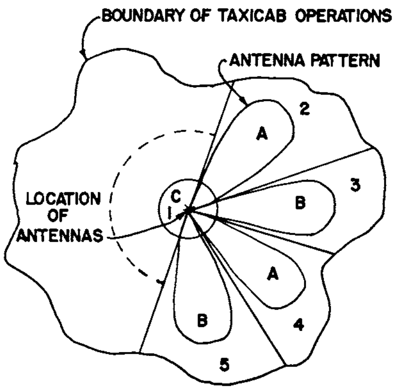

Figure 6. Three-channel system based on sectoral divisions with a circular area at the center which is served by the third channel

directive antenna secondary-lobe interference, which can be expected; see Figure 6. This plan may be very useful in a city that is relatively flat, that does not have many tall structures, and that is built around a central point where a number of important traffic arteries converge. Washington, D. C., is an example.

This plan would be a very poor choice for a large sprawling city composed of a number of distinct and almost self-contained districts. Philadelphia is such a city. The type of pattern illustrated in Figure 5 may be an excellent choice for Philadelphia. This pattern has one distinct advantage in that it permits use of omnidirectional antennas in place of the highly directional type of the radial pattern.

SELECTIVE CALLING

SELECTIVE-CALLING equipment permits a dispatcher to call any one cab, any group of cabs, or all cabs by operating a push-button control board. The call is heard only by the cab or cabs to which it is directed.

Selective-calling equipment is not essential to the operation of the communication system that has been outlined, but its use offers certain distinct advantages. These are summarized briefly:

Elimination of Nuisance Interference. The area and frequency allocations have been set up so that the base station within a given area is always stronger than interfering signals from other areas on the same frequency. In the presence of both signals, the receiver will respond to the stronger one and no appreciable interference will be heard. However, in some places the weaker station may be audible when the strong station is not transmitting. Selective calling would eliminate this nuisance interference as well as all other calls not directed to a particular cab or group of cabs.

Reduction in Driver Fatigue. Without selective calling, a driver must pay constant attention to all dispatched calls. Undoubtedly, this will affect his efficiency and may make him miss a call once in a while.

Increased Passenger Comfort. Some taxicab operators report that passengers often object to the radio chatter and they request the driver to turn off his receiver.

Many taxicab operators objected to the slowness of the old selective-calling equipment. Recently developed equipment puts through a call in less than one-half second. Provision can be made for individual calling, group calling, and general calling.