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(71) Applicant: **OPTIBUS LTD.** [IL/IL]; Hagavish 10, 4250708 Netanya (IL).

(72) Inventor: **YANOVSKY, Eitan**; Hagavish 10, 4250708 Netanya (IL).

(74) Agent: **BRASS, Adv. Daniel**; 16 McDonald Street, 42262 Netanya (IL).

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(54) Title: SYSTEM AND METHOD FOR REAL TIME SCHEDULING

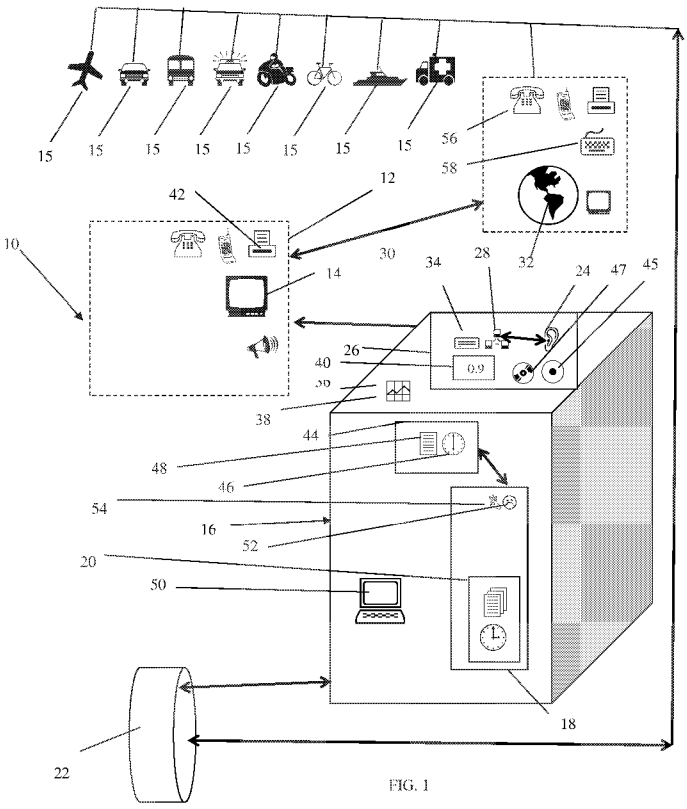

FIG. 1

(57) Abstract: The present invention relates to Real Time Scheduling systems. In particular, the present invention relates to real time transportation scheduling. More specifically, the present invention relates to novel improvements in transportation planning and allocation of resources on a real time basis by providing a system and method for "real time" scheduling including a client interface, a real time data processor for creating a prediction, an optimization engine electronically attached to the client interface and the real time data processor for readily producing a new schedule, and a transportation means electronically attached to the optimization engine and responsive to the new schedule.

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SYSTEM AND METHOD FOR REAL TIME SCHEDULING

FIELD OF THE INVENTION

The present invention relates to Real Time Scheduling systems. In particular, the present invention relates to real time transportation scheduling. More specifically, the present invention relates to novel improvements in transportation planning and allocation of resources on a real time basis.

BACKGROUND OF THE INVENTION

According to contemporary teachings of the art, a dispatcher, will often need to address one or more cases when the planned schedule cannot be met due to events that occur in real-time. Such events will typically include, by way of non-limiting examples only, heavy traffic causing delays, vehicular break downs and unpredicted demand.

Invariably, such events bring about an undesired result of at least one vehicle not to being able to meet with a planned schedule for that vehicle of a fleet of vehicles.

Thus, any such vehicle being late, can create bring about a further undesired outcome of delaying the next planned activity for that vehicle, line, fleet and the like.

Attempted solutions known in the art include, among others, AVL (automatic vehicle location) systems for indicating a "current location" of the vehicles.

Some attempted solutions will automatically notify that a vehicle is going to be late. Nevertheless, the systems known in the art do not offer an automatic rescheduling solution.

Moreover, a further latent deficiency of the systems known in the art is their lack of calculating planning restriction preferences and costs as an integral part of a rescheduling.

The existing scheduling systems offer offline scheduling which often take at least several hours or even days to create a new schedule and do not offer any real-time rescheduling system and especially none with an integrated with an AVL solution.

The current attempted solutions known in the art, include a dispatcher becoming aware there is a problem with a given schedule of a specific vehicle, line or fleet, and then attempts to "manually" reschedule the vehicles and drivers to address the issue. A latent deficiency of any such attempt is the limited calculative resources and limited parameters a human dispatcher can address.

It is well known in the art that a dispatcher, in attempting to resolve a real time scheduling dilemma, may opt to break regulations and/or offer a partial and/or inadequate solution which is far from optimal.

Even though one can find many control rooms with monitors that display the location of vehicles and in some cases display whether they are on time or going to be late to their next trip, once an indication is received that a vehicle is predicted not to perform a specific task within the time slot allocated

thereto, it is up to the dispatcher to handle such an occurrence by either accepting a delay or seeking to find an alternative solution utilizing the available resources of vehicles and/or drivers to replace and/or augment the delayed vehicle in completing the given task or at least one of the subsequent tasks according to the original schedule.

Often, a latent deficiency of any such system is that any solution proposed and/or implemented is based according to long running, time consuming optimizers in an offline long term process and are not suited for online solutions or providing real time basis solutions.

Any such "manual" rescheduling process is extremely challenging due to the problem size and complexity, vast number of variables and "domino effect" of any proposed solution which is far beyond the realm of the cerebral capabilities of a dispatcher.

There is a latent need to find a suitable alternative solution in a very short time frame and preferably on a substantially "real time" basis, as well as substantially contemporaneously addressing a wide range of changing and cross linked variables, different regulations, constraints and the challenge minimizing or wasting any resources.

Latent deficiencies commonly encountered by systems known in the art will often include: violations of operator rules, preferences, and regulations due to un-guarded changes; incurring delays for passengers due to the need to provide a solution in a short time period and non-optimal solution which results in inflated fleets, among others, due to large reserves being required, wasted costs

and pollution due to the complexity of the problem that needs to be solved in a short time period.

SUMMARY OF THE INVENTION

The present invention is a system and method for "real time" scheduling.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram view of the system and method for "real time" scheduling according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The system and method for "real time" scheduling according to the present invention, as described herein, readily facilitates updating/editing on a substantially "real time" basis and devoid of violations of operator rules, preferences, and regulations due to un-guarded changes; incurring delays for passengers due to the need to provide a solution in a short time period and non-optimal solution which results in inflated fleets, among others, due to large reserves being required, wasted costs and pollution due to the complexity of the problem that needs to be solved in a short time period.

As shown in Figure 1, a system and method for "real time" scheduling **10** according to the present invention includes a client interface **12**, wherein client interface **12** is preferably displayed as a Gantt chart. Optionally, client interface **12** includes at least one map display **14** for readily displaying the location of at least one transportation means **15**.

System and method for "real time" scheduling **10** preferably includes an optimization engine **16** and a data set **18**, wherein data set **18** preferably includes an existing schedule **20**.

Optionally, at least one map display **14** readily displaying the location of at least one transportation controller **22**, wherein transportation controller **22** controls transportation means **15** either remotely or locally. By way of an unlimiting example only, transportation controller **22** may be the driver of transportation means **15**.

System and method for "real time" scheduling **10** preferably also includes a real-time data listener **24** and a real-time stream processor **26**.

Alternatively, client interface **12** also includes a real-time data listener **24** and a real-time stream processor **26**.

Alternatively, optimization engine **16** also includes a real-time data listener **24** and a real-time stream processor **26**.

Preferably, during each work session of executing existing schedule **20**, a real-time feed **28** from at least one transportation means **15** is continuously fed into the real-time data listener **24** as a stream of data **30**.

Stream of data **30** preferably contains a raw positioning data **32**, real time feed **28**, or a processed data **34** for transportation means **15**.

Thus, permutations according to raw positioning data **32**, real time feed **28**, or a processed data **34** for transportation means **15** are readily calculated for the purpose of proactive analysis of transportation means **15** meeting schedule **20**.

Real-time stream processor **26** is preferably responsive to raw positioning data **32** being received, whereupon raw positioning data **32** is passed to real-time stream processor **26** for processing and calculating the probability of transportation means **15** not meeting the time frame allocated thereto in existing schedule **20**.

Preferably, Real-time stream processor **26** creates a prediction **36** based on raw positioning data **32** being received, and passed to real-time stream processor **26** on transportation means **15** meeting or not meeting the time frame allocated thereto in existing schedule **20**.

Preferably, real-time stream processor **26** will accumulate and provide data on the accuracy of probability calculations compared to actual performance of transport means **15** according to existing schedule **20**.

Preferably, real-time stream processor **26** includes a plurality of prediction models **45** and a history data **47** as optional parameters and/or fine tuning prediction **36**.

Preferably, prediction **36** includes of an expected arrival time **38** with a confidence score **40** (probability between 0 and 1), and an expected impact **42** by knowing how many passengers are expected to be on the next trip using statistical history.

Occasioning on prediction **36** of an expected arrival time **38** not meeting existing schedule **20** from an external feed (not shown in Figure 1) and/or the prediction **36**, the expected impact **42** is calculated and the client interface **12** is

notified and displays an alert with the nature and details pertaining to transportation means **15** not meeting existing schedule **20**.

Optionally, real-time stream processor **26** utilizes an expected arrival time **38** from an external feed (not shown in Figure 1) to compare to existing schedule **20**, the expected impact **42** and/or prediction **36** and client interface **12** is notified and displays an alert with or without the nature and details pertaining to transportation means **15** not meeting existing schedule **20**.

Optimization engine **16** is responsive to a request for a rescheduling and all the related information in a data set **18**.

The information in dataset **18** mainly contains the existing schedule **20**, the current location and/or raw positioning data **32** of transportation means **15** the expected arrival time **38** (both late and early), transportation controllers **22** and relevant planning constraints and preferences.

Optimization engine **16** creates at least one alternative **44** of a new schedule **46** based on existing schedule **20** which addresses delays compared to existing schedule **20**.

Preferably, client interface **12** displays alternatives **44** to be selected by a dispatcher **50**, controller **22** or equivalent thereof. Preferably, dispatcher **50** chooses whether to accept one or none of alternatives **44** according to the expected impact **42** and/or nature of the delay and initiates execution of new schedule **46** selected.

Optionally, controller **22** selects one or none of alternatives **44** and initiates execution of new schedule **46** selected.

Preferably, creating new schedule **46** should take a very short time, no more than a minute, in order for dispatcher **50** to have enough time to execute new schedule **46**.

It is envisaged that predictions **36** should be with high probability of substantially above 50% way in advance to have time notifying all the relevant controllers **22** and transportation means **15** about their changes due to new schedule **46**.

Optionally, it is envisaged that predictions **36** should be with high probability of substantially above 90% way in advance to have time notifying all the relevant controllers **22** and transportation means **15** about their changes due to new schedule **46**.

For the purpose of providing an advanced and/or accurate prediction **36**, real-time data processor **26** requires to process stream of data **30** including events and apply prediction models **45** to offer predictions **36** substantially on a real-time basis.

Preferably, using distributed in memory streaming processes, in memory streaming processor **26**, together with a model **45** from pre-trained on history data **47**, model **45** is fine-tuned and updated in a batch process from the real-time stream of data **30** using machine learning algorithms known in the art.

Preferably, Optimization engine **16** is electronically attached to or integrally formed with dataset **18**, which dataset **18** preferably includes a plurality of operator planning restrictions **52**, existing schedule **20** and planning

preferences **54** for readily calculate a few rescheduling alternatives **44** in order for the result to be applicable.

Preferably, Optimization engine **16**, creates rescheduling alternatives **44** utilizing dataset **18**.

Preferably, real-time data listener **24** is an endpoint that listens to real-time feed of transportation means **15** and the raw positioning data **32** of transportation means **15** as well as processed data **34**, and transfers raw positioning data **32** and/or processed data **34** to real-time stream processor **26**.

Preferably, real-time stream processor **26** processes the real-time feed of stream of data **30**, raw positioning data **32** and/or processed data **34**.

Preferably, real-time stream processor **26** applies prediction models **45** on stream of data **30**, raw positioning data **32** and/or processed data **34** combining with additional data sources such as traffic reports and the like.

Preferably, real-time stream processor **26** also keeps training and fine-tuning prediction model **45** using the accumulated data.

Occasioning on an expected impact **42** indicating a delay is predicted with high probability and of a high magnitude, preferably, client interface **12** indicates the delay and/or optimization engine **16** for a new schedule **46** and/or an alternative **44** to be calculated bearing in mind related and/or relevant expected times of arrival **38**, predictions **36**, models **45**, history data **47**, operator planning restrictions **52** and planning preferences **54**.

Substantially thereafter, stream processor **26** sends the relevant dataset **18** to optimization engine **16** and substantially thereafter optimization engine **16** relays for new schedule **46** to client interface **12**.

Preferably, upon client interface **12** receiving a prediction **36** of a transportation means **15** not meeting an expected time of arrival **38** according to existing schedule **20**, client interface **12** displays a notice and notifies dispatcher **50** about the expected delay of transportation means **15**.

Preferably, upon client interface **12** receiving a prediction **36** of a transportation means **15** not meeting an expected time of arrival **38** according to existing schedule **20**, client interface **12** displays new schedule **46** and/or new expected times of arrival **48** to dispatcher **50**.

Upon client interface **12** receiving a prediction **36** of a transportation means **15** not meeting an expected time of arrival **38** according to existing schedule **20**, client interface **12** displays information selected from the group consisting of: which part or existing schedule **20** is expected not to be met, raw positioning data **32** pertaining to transportation means **15** effected and other relevant transportation means **15**.

Upon client interface **12** receiving a new schedule **46** and/or an alternative **44**, from optimization engine **16**, client interface **12** displays to dispatcher **50** at least one of the parameters selected from the group consisting of: a new schedule **46** and/or an alternative **44** thereby readily facilitating dispatcher **50** to select and/or execute a new schedule **46** and/or an alternative **44**.

Preferably, occasioning on optimization engine **16** receiving a request for creating a new schedule **46**, the relevant arrival predictions **36**, optimization engine **16** initiates a new rescheduling process which preferably includes the following steps:

a. Parsing dataset **18** with at least one of parameters selected from group consisting of history data **47** activity for transportation means **15**, planning preferences **54**, planning constraints **52** and arrival predictions **36**.

b. Removing from existing schedule **20** tasks of transportation means **15** effected by the delay prediction **36**.

c. Starting an iterative process for rescheduling the effected tasks to other transportation means **15** and/or transportation controllers **22** (including reserve transportation means **15** and/or reserve transportation controllers **22**) substantially contemporaneously with calculating and producing a cost efficient new schedule **46**. Preferably, optimization engine **16** prioritizes locations that minimize disruption of tasks already in existing schedule **20**, and from those to most efficient ones.

d. Occasioning on such a location not being available, optimization engine **16** will preferably calculate impact **42** of using a new transportation means **15** or replacing an existing task in existing schedule **20** effected by expected time of arrival **38** of prediction

36, and move and/or relocate the replaced task to the reschedule process as part of new schedule **46**.

e. Preferably, optimization engine **16** creates a new schedule **46** and/or new expected times of arrival **48** according to preferences **54** and constraints **52**.

f. Preferably, optimization engine **16** calculates new schedule **46** and/or new expected times of arrival **48** substantially contemporaneously with a plurality of prediction models **45** thereby creating a plurality of predictions **36** and/or new schedule and branching into a tree of feasible alternatives.

g. Preferably and occasioning on optimization engine **16** completing calculations of pertinent new schedules **46** and/or new expected times of arrival **48**, optimization engine **16** transfers new schedules **46** and/or new expected times of arrival **48** to client interface **12** with detailed cost changes and/or impact **42** on existing schedule **20**.

Preferably, real time data listener **24** is a passive component which real time data listener **24** receives raw positioning data **30**.

Preferably, real-time stream processor **26** is responsive to receiving processed data **34**, and/or expected times of arrival **38** and/or predictions **36** of existing schedule **20** is expected not to be met.

Preferably, real time data listener **24** receives traffic updates from sources of traffic updates known in the art and/or external sources.

In operation, real time data listener **24** preferably transfers to stream processor **26** at least one of the parameters selected from the group consisting of: raw positioning data **30,** processed data **34** with expected times of arrival **38** and predictions **36** of existing schedule **20** is expected not to be met.

By way of example only, predictions **36** of a 10 minute delay is calculated for transportation means compared to existing schedule **20**. Thereafter, system and method for "real time" scheduling **10** checks whether existing schedule **20** can be optimized, the specific task can be optimized by changing route or not just the specific task being performed by the transportation means **15**, thus readily addressing and substantially circumventing patterns of escalation in dataset **18**.

Alternatively, system and method for "real time" scheduling **10** checks whether changing the allocation of resources and/or augmenting with assets can minimize or negate prediction **36** of expected times of arrival **38** according to existing schedule **20** not being met. Thus, preferably system and method for "real time" scheduling **10** continuously calculates, changes and adapts prediction **36** with alternating values, thereby providing a solution and/or optimizing results to reach or exceed a delay value of zero minutes or less (meaning arriving "ahead of time").

Preferably, if a score **40** of at least 50% probability of a 5 minute delay from expected times of arrival **38** according to existing schedule **20** are reached, system and method for "real time" scheduling **10** checks whether existing schedule **20** can be optimized.

Preferably, if a score **40** of 50% probability of 5m delay from expected times of arrival **38** according to existing schedule **20** are reached, system and method for "real time" scheduling **10** checks whether existing schedule **20** for entire day can be optimized and not just the specific task being performed by the transportation means **15**, thus readily addressing and substantially circumventing patterns of escalation in dataset **18**.

Preferably, if 50% probability or 5m delay from expected times of arrival **38** according to existing schedule **20** are reached, system and method for "real time" scheduling **10** checks whether changing the allocation of resources and/or augmenting with assets can minimize or negate prediction **36** of expected times of arrival **38** according to existing schedule **20** not being met.

Preferably, calculation of new schedule **46** and/or new expected times of arrival includes number of passengers according to history data **47**, thereby further fine tuning new schedule **46**.

Preferably, according the embodiments and description of system and method for "real time" scheduling **10** according to the present invention, of system and method for "real time" scheduling **10** System is both reactive and proactive with regard to predictions **36** and impact **42**.

Preferably, transportation means **15** includes a telemetry subsystem **56** for transferring telemetry data **58** regarding the transportation means **15** on a substantially real-time basis.

Preferably, telemetry data **58** includes at least one parameter selected from the group consisting of: a weather condition, a raw positioning data **32**, a

speed, a tire pressure, an oil pressure, a G force in 3 axis, a tire rate of deterioration, an acceleration rate, an oil temperature, a water temperature, an engine temperature, a wheel speed, a suspension displacement, controller **22** information, a two way telemetry transmission for remote updates, calibration and adjustments of a component of transportation means **15**, expected tire change required, expected refueling required and an expected servicing required.

By way of example only, prediction **36** can produce a new planning restriction **54** due to a scheduled and/or required maintenance, pit stop, refuel, and tire change and the like.

The term "transportation means " as used herein, shall include but will not be limited to: a means of conveyance or travel from one place to another including a vehicle or system of vehicles, such as a bus, a train, a ship, a boat, a taxi, a car, an automobile, a two and three wheeled vehicle, a sea vessel, an aircraft or an airborne carrier and the like for private and public conveyance of passengers or goods especially as a commercial enterprise, a means of

transportation, a controller of a means of transportation, a bank energy resource for a means of transportation, a loading station for loading a means of transport, an off-loading station for off-loading a means of transport and the like.

It will be appreciated that the above descriptions are intended to only serve as examples, and that many other embodiments are possible within the spirit and scope of the present invention.

What is claimed is:

1. A system and method for "real time" scheduling comprising:

(a) a client interface;

(b) a real time data processor for creating a prediction

(c) an optimization engine electronically attached to said client interface and said real time data processor for readily producing a new schedule; and

(d) a transportation means electronically attached to said optimization engine and responsive to said new schedule.

2. The system and method for "real time" scheduling of claim 1, further comprising a dataset including at least one parameter selected from the group consisting of: a plurality of tasks, a history data, a prediction model, a planning constraint and a planning preference.

3. The system and method for "real time" scheduling of claim 2, wherein said client interface further comprising a controller.

4. The system and method for "real time" scheduling of claim 3, wherein real time data processor is responsive to a set of telemetry data, wherein telemetry data includes at least one parameter selected from the group consisting of: a weather condition, a raw positioning data, a speed, a tire pressure, an oil pressure, a G force in 3 axis, a tire rate of deterioration,

an acceleration rate, an oil temperature, a water temperature, an engine temperature, a wheel speed, a suspension displacement, a controller information, a two way telemetry transmission for remote updates, calibration and adjustments of a component of transportation means, expected tire change required, expected refueling required and an expected servicing required.

5. A system and method for "real time" scheduling comprising:

(a) a client interface including a controller;

(b) a real time data processor for creating a prediction

(c) an optimization engine electronically attached to said client interface and said real time data processor for readily producing a new schedule;

(d) a transportation means electronically attached to said optimization engine and responsive to said new schedule; and

(e) a dataset including at least one parameter selected from the group consisting of: a plurality of tasks, a history data, a prediction model, a planning constraint and a planning preference.

6. The system and method for "real time" scheduling of claim 5, wherein said real time data processor is responsive to a set of telemetry data, and wherein said telemetry data includes at least one parameter selected from the group consisting of: a weather condition, a raw positioning

data, a speed, a tire pressure, an oil pressure, a G force in 3 axis, a tire rate of deterioration, an acceleration rate, an oil temperature, a water temperature, an engine temperature, a wheel speed, a suspension displacement, a controller information, a two way telemetry transmission for remote updates, calibration and adjustments of a component of transportation means, expected tire change required, expected refueling required and an expected servicing required.

7. The system and method for "real time" scheduling of claim 5, wherein said client interface includes at least one map display for readily displaying the location of said transportation means.

8. The system and method for "real time" scheduling of claim 5, wherein said dataset includes at least one existing schedule.

9. The system and method for "real time" scheduling of claim 7, wherein said at least one map display readily displays the location of at least one transportation controller.

10. The system and method for "real time" scheduling of claim 9, wherein said transportation controller controls said transportation means remotely or locally.

11. The system and method for "real time" is the driver of said transportation means.

12. The system and method for "real time" scheduling of claim 5, further comprising a real-time data listener and a real-time stream processor.

13. The system and method for "real time" scheduling of claim 12, wherein executing said existing schedule, during each work session, a real-time feed from at least one said transportation means is continuously fed into said real-time data listener as a stream of data.

14. The system and method for "real time" scheduling of claim 13, wherein said stream of data preferably includes a raw positioning data, a real time feed, or a processed data for said transportation means.

15. The system and method for "real time" scheduling of claim 14, wherein said real-time stream processor is preferably responsive to said raw positioning data being received, whereupon said raw positioning data is passed to said real-time stream processor for processing and calculating the probability of said transportation means not meeting the time frame allocated thereto in said existing schedule.

16. The system and method for "real time" scheduling of claim 15, wherein said real-time stream processor creates a prediction based on said raw positioning data being received, and passed to said real-time stream processor on said transportation means meeting or not meeting the time frame allocated thereto in said existing schedule.

17. The system and method for "real time" scheduling of claim 15, wherein said optimization engine is electronically attached to or integrally formed with said dataset, and which dataset preferably includes a plurality of operator planning restrictions, said existing schedule and a plurality of planning preferences for readily calculating at least one rescheduling alternative.

18. The system and method for "real time" scheduling of claim 15, wherein said real-time data listener is an endpoint that listens to said real-time feed of said transportation means and said raw positioning data of said transportation means as well as said processed data, and transfers said raw positioning data and/or said processed data to said real-time stream processor.

19. The system and method for "real time" scheduling of claim 15, wherein said real-time stream processor applies at least one prediction model on said stream of data, said raw positioning data and/or said processed data

and wherein said real-time stream processor keeps training and fine-tuning said at least one prediction model using the accumulated data.

20. The system and method for "real time" scheduling of claim 15, wherein if a score of at least 50% probability of a 5 minute delay from an expected times of arrival according to said existing schedule are reached, said system and method for "real time" scheduling performs at least one of the tasks selected from the group consisting of: checking whether said existing schedule can be optimized, checking whether said existing schedule for an entire day can be optimized for readily addressing and substantially circumventing patterns of escalation in said dataset, checking whether a change in an allocation of resources and/or an augmentation with at least one asset can minimize said prediction of said expected times of arrival according to said existing schedule not being met.

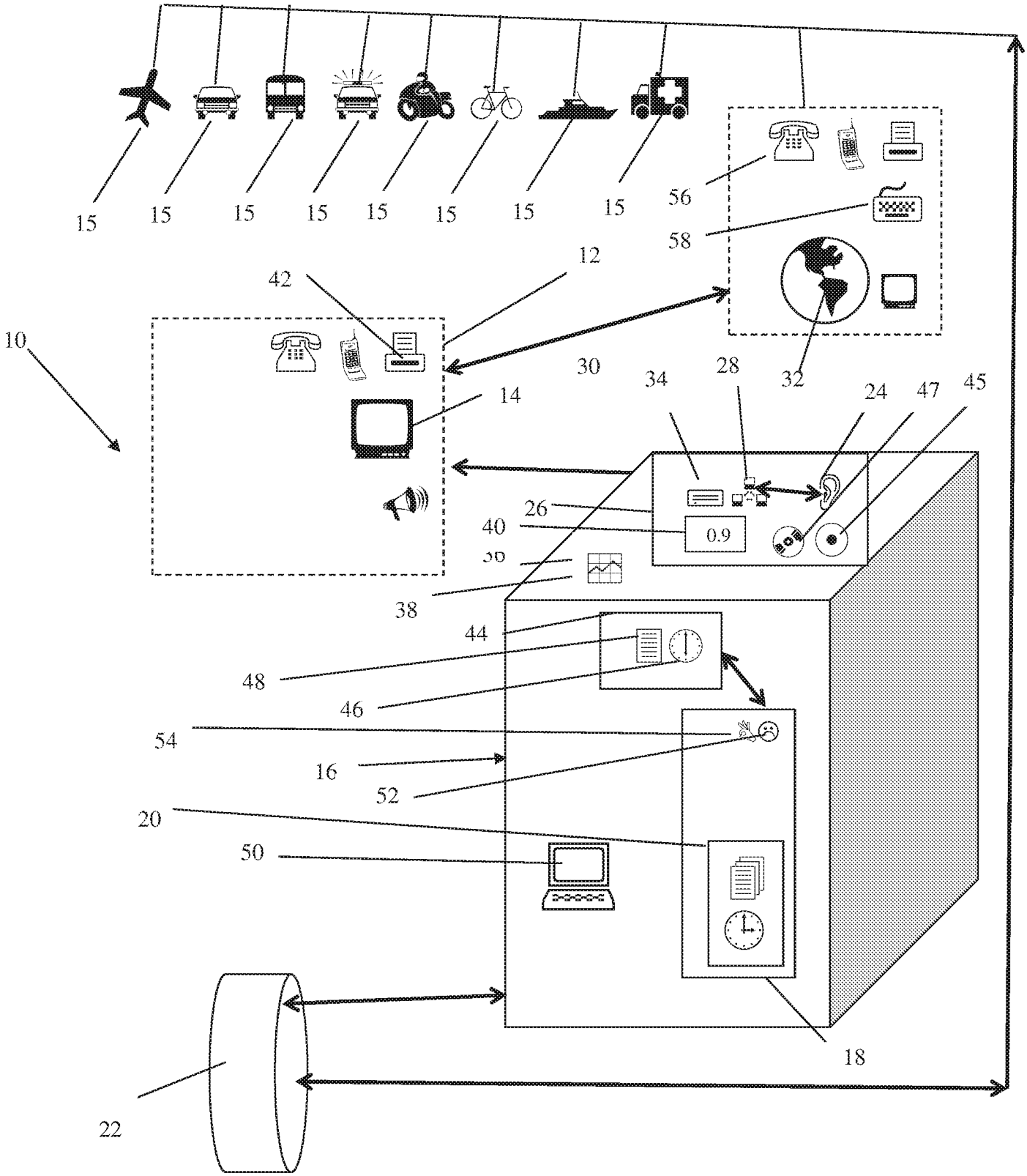
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FIG. 1