multiple processors to execute individual portions of multiple-processor execution requests (i.e., execution latencies), in addition to (or as part of) communications latencies.

Summary

[0007] In various aspects the invention provides systems, methods, and computer-executable instruction mechanisms (e.g., non-transient machine-readable programming structures) such as software-coded instruction sets and data, for the management of data processing by multiple networked computing resources. In particular, for example, the invention provides systems, methods, and coded instruction sets useful in controlling the synchronization of related requests for processing of data using distributed network resources.

[0008] For example, in a first aspect the invention provides systems, methods, and programming or other machine-interpretable instructions for causing synchronized processing of data by multiple networked computing resources, such systems, for example, comprising at least one processor configured to execute machine-interpretable instructions and causing the system to:

receive from one or more data sources signals representing instructions for execution of at least one data process executable by a plurality of networked computing resources;

divide the at least one data process into a plurality of data processing segments, each data processing segment to be routed to a different one of a plurality of networked execution processors;

based at least partly on latencies in execution of prior data processing requests routed by the system to each of the plurality of networked execution processors, determine a plurality of timing parameters, each of the plurality of timing parameters to be associated with a corresponding one of the plurality of data processing segments, the

plurality of timing parameters determined to cause synchronized execution of the plurality of data processing segments by the plurality of networked execution processors; and

using the timing parameters associated with the plurality of data processing segments, routing the plurality of data processing segments to the plurality of corresponding networked execution processors.

[0009] In some embodiments, as will be explained herein, the networked execution processors can, for example, comprise exchange servers, and the data processing segments represent requests for trades in financial interests such as commodities and/or intangible interests such as stocks, bonds, and/or various forms of options.

[0010] The plurality of determined timing parameters can be used in determining and implementing timing sequences in order to implement desired sequential execution of data processing requests in accordance with the invention, and can for example represent and/or be based wholly or partially upon latencies in execution of data processing requests due many factors. For example, such parameters can be wholly or partially based on dynamically-monitored latency(ies) in execution of signal processing requests previously routed by the system to at least one of the plurality of networked execution processors. Such latencies may be caused by many factors, including, for example, various types of communication and data processing delays. Such timing parameters may further based on statistical, e.g., probability models of observed latency data, and patterns therein.

[0011] Such systems, methods, and programming or other machine-interpretable instructions may further be configured such that they cause a system to:

associate with each of at least one of the plurality of data processing segments data representing at least one quantity term, the at least

one quantity term representing at least one quantity of a financial interest to be traded in accordance with a request represented each of the at least one data processing segments, and at least one corresponding price term associated with each such quantity term, the quantity term representing at least one proposed price at which a trade represented by the at least one data processing segment is to be executed;

the at least one quantity term larger than at least one quantity of the financial interest publicly offered at a price equivalent to the corresponding associated price term, in a market associated with the networked execution processor(s) to which the at least one data processing segment is to be routed.

[0012] Such quantity terms can, for example, be determined based at least partly on trading histories associated with the market(s) associated with the networked execution processor(s) to which the data processing segments are to be routed. They can be determined on data relating to displayed or undisplayed offerings and/or trades, including for example historical undisplayed oversize or reserve quantities.

[0013] In further aspects the invention provides systems, methods, and programming or other machine-interpretable instructions for causing synchronized processing of data by multiple networked computing resources, such systems, for example, comprising at least one processor configured to execute machine-interpretable instructions and causing the system to:

monitor execution of signal processing execution requests by each of the plurality of networked computing resources;

determine at least one timing parameter associated with a latency in execution of signal processes between the system and each of the plurality of networked computing resources; and

store the at least one timing parameter in machine-readable memory accessible by the at least one processor.

Monitoring of execution of signal processing execution requests according to such and other embodiments of the invention can be implemented on continual, periodic, and/or other suitable or desirable bases.

[0014] In various embodiments of the various aspects of the invention, the networked computing resources can include one or more exchange servers. The data sources can include one or more broker or trader systems or servers, the controlled signal processes can represent trades in financial interests, and the execution of signal processing execution requests represents the execution of transactions in financial interests, including for example stocks, bonds, options and contract interests, currencies and/or other intangible interests, and/or commodities. In such embodiments requests for execution of data processing procedures can be based wholly or partially on parameters including, for example, any one or more of current market data quotations, order routing rules, order characteristics, displayed liquidity of each networked computing resource, and a probable delay, or latency, in execution of an order quantity at each networked computing resource.

[0015] In the same and further aspects the invention provides systems for controlling or otherwise managing requests for processing of data by distributed computer resources, such systems including one or more processors configured to execute instructions for causing the system to:

monitor execution of signal processing execution requests by each of the plurality of networked computing resources;

determine at least one timing parameter associated with the latency in execution of signal processes between the system and each of the plurality of networked computing resources; and

store the at least one timing parameter for each of the plurality of networked computing resources.

[0016] Among the many advantages offered by the invention is the possibility of monitoring latencies and other factors in networked processing of multi-part or other complex data processing requests on a dynamic, or 'rolling', basis, and using such dynamically-monitored latencies and/or other factors in determining timing parameters to be used in implementing synchronized processing requests, as disclosed herein. Timing parameters used in implementing synchronized processing requests can be monitored and/or determined on continuous, continual, periodic, or other bases, depending upon the needs, objectives, and other factors of the applications in which they are to be applied.

[0017] A further advantage offered by the invention is reduction or elimination of the need for consideration of one-way communications latencies, e.g., the need to minimize latencies in communications between routing and execution processors.

[0018] As will be appreciated by those skilled in the relevant arts, once they have been made familiar with this disclosure, synchronization of execution of distributed data processing requests by, for example, synchronized transmission of requests for such processing, has a great many possible applications in a large number of data processing fields.

Brief Description of the Drawings

[0019] Reference will now be made to the drawings, which show by way of example embodiments of the present disclosure.

[0020] FIGS. 1A, 1B, and 3 show examples of systems suitable for causing processing of data by multiple networked computing resources in accordance with various aspects of the invention.

[0031] Networked computing resources 106 may include any devices or other resources that communicate with router processor(s) 104 to receive and carry out any of a very wide variety of data processing requests. Such networked computing resources 106 may include systems, servers, processors or any other suitable devices adapted for execution of any processes suitable for use in implementing the invention, including, for example, processing of offers or bids for purchase of commodities, financial interests, etc., and/or other data processing tasks, such as word or document processing, image, and/or other communications or documentation tasks.

[0032] In various embodiments, the one or more data sources 102 transmit or otherwise provide to or for the router processor(s) 104 signals representing instructions, or requests, for executing data processing functions. Instructions from any given data source(s) 102 may include instructions for signal processes to be executed by any one or more networked computing resources 106. Requested signal processes may include, for example, computing operations, data manipulations, and/or communications processes or other signal exchanges, among others. In some but not necessarily all examples, such instructions may specifically identify networked computing resource(s) 106 particularly targeted for execution of such processes.

[0033] Router processor(s) 104 may parse instruction signals received from one or more source(s) 102 and use such signals to prepare instructions, or requests, to be forwarded to pluralities of execution processors 106, for execution of data processing and/or other signal processes in accordance with the received instructions. Parsing of such instructions may include, for example, identifying the type of process(es) to be requested, including for example the volume or quantity of an order or bid for a trade or an amount of document processing to be done, and the type, nature, and/or identity(ies) of networked computing resource(s) 106 to be requested to

[0036] As a further example, single instruction sets for processing of data may be broken down by processor(s) 104 and distributed to a plurality of resources 106 for distributed execution. For example, a relatively large order for trading in one or more financial interests originating from a single source 102a, 102b, might need to be distributed to multiple exchange servers 106 in order to be completely filled; in such cases request(s) from one or more source(s) 102 may be broken down by processor(s) 104 into suitable orders for execution by a plurality of such resources 106.

[0037] Targeted, or specifically identified, networked computing resources / execution processors 106 communicate with the router processor(s) 104 to receive the segmented signal process execution requests and may thereafter execute them accordingly. Execution of such signal processes may include, for example, carrying out a text- or image-processing operation, a mathematical computation, or a communications signal exchange, among others.

[0038] As will be readily understood by those skilled in the relevant arts, various components of system 100 may combined, or may be implemented in the form of separate systems or devices. In a wide variety of configurations, such combined or separate (sub)systems may be operated by the same or distinct entities. As a particular example, one or more request source(s) 102 may be integrated with, or otherwise associated with, individual router(s) 104.

[0039] An example of an application of a system 100 for distributed execution of segmented processing requests in accordance with the invention is provided by a financial system 1000 adapted for processing of requests for processing of data representing trades and/or offers for trades, or other transactions, in tangible and/or intangible financial interests such as stocks, bonds, currencies (e.g., foreign exchange), various forms of natural resources or commodities, options, loans, etc. As shown in Figures 1A and 1B, for example, in a financial transaction data processing system 1000 in

accordance with the invention, signal or data source(s) 102 may include trader system(s) 1102, which may, for example, include trader/broker systems or servers as well as any other sources of bids, offers, or other transactions in financial interests such as currently provided by known financial trading platforms. In various embodiments, such trader systems 1102 may be referred to as order origination systems.

[0040] Order origination systems 1102, 102a may include systems operated by or on behalf of, for example, entities owned or otherwise controlled by parent or other controlling organizations such as banks or brokerage houses. Order origination systems 1102, 102b may, for example, include systems operated by or on behalf of brokers or other trading entities acting on behalf of, for example, individual investors, trading through or with the assistance of independently-controlled banks, institutional investors, and/or other brokerage houses.

[0041] Router processor(s) 104 in such embodiments may include, for example, server(s) or other system(s) 1104 that communicate with trader systems 1102, 102, for example through the receipt and transmission of encoded electronic signals representing requests for processing of data representing execution and/or acknowledgement of transactions in financial interests; and which communicate with broker, exchange, or other market systems or execution processor(s) 1106 for execution of such transactions. In such embodiments a processor 104 may be referred to as a Smart Order Router or Tactical Hybrid Order Router (in either case, "SOR") 1104, 104. An SOR 1104 may, for example, include one or more gateway(s) 1122 and/or router(s) 1124 for facilitating communications by router(s) 1104 with one or more trader systems 1102, 102 directly (e.g., through wired communication, using one or more dedicated communication channel(s), or through communication within a single server) and/or indirectly (e.g., through wireless communication, through a network 108, 1108 or through an intermediate server). Exchange or market systems 1106, or other execution processor(s) 106 may be in communication with SOR(s) 1104 through, for

segment thereof, or any other desired time period(s), which may be preset and/or dynamically determined by processor(s) 104, 1104. Instructions may be also be processed individually, as received. If more instructions are to be received prior to processing, or may potentially be received, process 200 can return to 202.

[0055] Transaction requests / instructions may be accumulated during defined time intervals, such as the duration of a business day or any segment thereof, or a desired time period, which may be preset and/or dynamically determined by processor(s) 104, 1104. If more instructions to be received, or may potentially be received, process 200 can return to 202.

[0056] In embodiments of the invention which employ sorting / aggregation techniques in parsing or otherwise preparing order or other processing requests, at 206 processor(s) 104, 1104 can repeat process 202 – 204 until all needed or desired related or aggregatable processing request signal sets have been received from source(s) 102, 1102. For example, as described above, arbitrary numbers of data records representing orders or requests for purchase of bonds identifiable by CUSIP (Committee on Uniform Security Identification Procedures) numbers can be received from data source(s) 102, 1102, and stored in memory 118, 1018 associated with the processor(s) 104, 1104, for batch processing, thus:

<source 1><sell><CUSIP No. AA><10,000><price A><res. 9,000><price D>
<source 2><buy><CUSIP No. BB><12,000><price C><res. 1,000><price B>
<source 3><sell><CUSIP No. BB><11,000><price A><res. 8,000><price D>
<source 6><sell><CUSIP No. AA><14,000><price A><res. 2,000><price E>
<source 4><buy><CUSIP No. AA><18,000><price C><res. 7,000><price B>
<source 1><sell><CUSIP No. BB><20,000><price A><res. 3,000><price D>
<source 3><sell><CUSIP No. AA><13,000><price A><res. 6,000><price D>
<source 4><buy><CUSIP No. BB><22,000><price C><res. 4,000><price B>
<source 5><sell><CUSIP No. AA><21,000><price A><res. 5,000><price E>
<source 4><buy><CUSIP No. BB><15,000><price C><res. 7,000><price F>
<source 1><sell><CUSIP No. AA><19,000><price A><res. 3,000><price D>
<source 5><buy><CUSIP No. BB><16,000><price C><res. 8,000><price F>
<source 6><sell><CUSIP No. BB><17,000><price A><res. 6,000><price H>

[0057] Upon individual receipt, or at a given periodic rate, a given time, when a given number of orders has been received, when all desired orders have

<buy><CUSIP No. BB><65,000><price C><res. 15,000><price E>
<res. 5,000><price B>

<sell><CUSIP No. BB><48,000><price A><res. 11,000><price D>
<res. 6,000><price H>

[0059] When all desired signal sets have been received at 202, and optionally sorted, accumulated, and/or otherwise processed at 204, at 208 processor(s) 104, 1104, using instruction sets processed at 204, can prepare execution-request signal sets for transmission to resources / execution processors 106, 1106. Such execution-request signal sets can comprise any necessary or desirable signals for causing requested processing, including content or data and command signals. For example, in embodiments of the invention adapted for processing of requests for transactions in financial interests, requests may be sorted and/or aggregated on the basis of interest(s) to be traded, quantities of interest(s) to be traded, price, etc., and associated with suitable execution command signals. The form of any execution command signals associated with a given request can depend, as those skilled in the relevant arts will recognize, on the nature and type of requests to be executed and the processors 106, 1106 by which they are to be executed, as well any networks 110, 1110 over which signals exchanged between processor(s) 104, 1104 and 106, 1106 are to be sent, including applicable protocols and instruction formatting requirements. Ergo, data pertaining to any or all of systems 106, 1106, 104, 1104, and 110, 1110, protocols used thereby, and/or information related to interests traded, offered, or described thereby may be accessed and used by processor(s) 104, 1104 in parsing and preparing instructions for execution of processing by any of processors or resources 106, 1106. Sources 1126 of such data may include, for example, exchange market data system 1126v (Figure 1b) which, for example, in embodiments of the invention adapted for processing of financial transactions, can include information received from various exchange systems 1106, news information sources such as Bloomberg or Reuters, and/or other sources.

[0060] It is sometimes necessary or desirable, in assembling requests for data processing using networked processing resources, including many resources configured for use in executing financial transactions, to break execution and/or other processing requests into multiple parts. Such parts, or segments, can, for example, correspond to portions of larger orders or other data processing requests, to be executed by a plurality of networked resources 106 such as exchange servers or other execution processor or handlers 1106. For example, if a plurality of exchange servers or other markets are available for execution of a transaction request representing a purchase order for a significant amount of a financial interest such as a stock or bond, it may be necessary or desirable to split the order into multiple parts, for execution in multiple markets and/or by multiple exchange servers 1106. For example, sufficient quantities of specific interests may not be available, at all or at desirable prices, on a single exchange: in order to fill an order entirely, it may be necessary or desirable to break a single order into smaller segments and route it to multiple exchanges.

[0061] Thus, for example, in various embodiments of the invention directed toward the processing of requests for transactions in financial instruments, when a router 104,1104 is requested by one or more sources 106, 1106 to complete a transaction in one or more financial interests, the router 104, 1104 can, in preparing signal set(s) representing requests for the transactions, access information available from sources such as market data source(s) 1126, as well as any one or more execution processor(s) 106, 1106, to determine the quantities of such interests available through the respective processors 106, 1106 and the terms under which such quantities are available, and can construct an execution request signal set configured for routing to each of the respective desired processors 1106, 1106, based on the number of quantities available at the most favorable terms.

[0062] For example, continuing the example above, it may be necessary or desirable to split one or more incoming processing requests into smaller parts, directed to a plurality of exchanges, in order to obtain fulfillment of the

synchronize the execution of signal processing execution requests, or portions or segments thereof, in multiple networked computing resources 106, 1106, for example such that the signal processes are received, acknowledged, and/or executed by the resources 106, 1106 in a substantially concurrent manner.

[0071] In some examples it may not be necessary for the signal processes to be executed in each processor 106, 1106 to be executed simultaneously, but may be sufficient that:

Time Y – Time X < Time A, and/or

Time Z – Time X < Time B,

such that execution of the request(s) or segments thereof occurs before any change in terms can be implemented by a trading server 304. The use of such synchronized timings can, for example, cause:

Time X + Time A > Time Y and/or
Time X + Time B > Time Z

and thus, for example, defeat latency arbitrage opportunities. In some embodiments, therefore, the invention provides router(s) 104, 1104 the ability to execute transactions across multiple resources 106, 1106 with minimal or no time variance, such that algorithms run by trader(s) 304 employing low-latency algorithms are given insufficient time to react to market changes.

[0072] Thus, in these and other cases where synchronization is desired, at 210 processor / router 104, 1104 can determine absolute or relative timings to be assigned to, or otherwise associated with, various portions or segments of an execution request, in order to obtain the desired sequencing. Such timings can be determined in order to cause any desired synchronization: for example, timings configured to cause simultaneous, or substantially

[00104] As will be readily understood by those skilled in the relevant arts, systems 100, 1000 can comprise devices or components suitable for providing a wide variety of further metrics and functionalities. For example, reference is now made to FIG. 7, which illustrates two examples of the provision by a routing processor 104, 1104 or other processor of a benchmark comparison relative to a market average price provided by, for example, a market news service or other market data source 1126v. At 646, performance of a system 100, 1000 in synchronized processing of a multi-part transaction request in accordance with the invention is compared to a market performance indicator "Average Price Benchmark." Such average price benchmark, or other benchmark or metric factor, can be obtained from, for example, any or all of components 1126, 1106, etc. At 644, performance of a system 100, 1000 in un-synchronized processing of a multi-part transaction request in accordance with prior art methods is compared to the same market performance indicator "Average Price Benchmark." Comparison of comparisons 646, 644 indicates that processing of transactions in accordance with the invention provides better results for a seller of financial interests. As will be understood by those skilled in the relevant arts, a wide variety of benchmarks may be used in assessing performance of systems and methods according to the invention. Such benchmarks may be determined at least partially by the nature of the system 100, 1000 used, and the types of transactions or other execution requests processed by such system.

[00105] In the embodiment shown in Figure 1B, source(s) 1126 of data useable by processor(s) 104 in preparing financial transaction or other data processing execution requests includes a plurality of modules 1126a-g useful in preparing a multi-part execution request. In the example shown, modules 1126a-g include market data processing module 1126a, exchange round-trip latency measurement module 1126b, adaptive exchange round-trip latency (RTL) learning & compensation logic module 1126c, smart sweeping share allocation logic module 1126d, smart posting logic module 1126e, regional & national exchange access logic module 1126f, and aggressiveness management module 1126g.

What is claimed is:

1. A system for causing synchronized processing of data by multiple networked computing resources, the system comprising at least one processor configured to execute machine-interpretable instructions and causing the system to:

receive from one or more data sources signals representing instructions for execution of at least one data process executable by a plurality of networked computing resources;

divide the at least one data process into a plurality of data processing segments, each data processing segment to be routed to a different one of a plurality of networked execution processors;

based at least partly on latencies in execution of prior data processing requests routed by the system to each of the plurality of networked execution processors, determine a plurality of timing parameters, each of the plurality of timing parameters to be associated with a corresponding one of the plurality of data processing segments, the plurality of timing parameters determined to cause synchronized execution of the plurality of data processing segments by the plurality of networked execution processors; and

using the timing parameters associated with the plurality of data processing segments, route the plurality of data processing segments to the plurality of corresponding networked execution processors.

2. The system of claim 1, wherein at least one of the plurality of determined timing parameters is determined based at least partly on dynamically-monitored latency in execution of signal processing requests routed by the system to at least one of the plurality of networked execution processors.

3. The system of claim 1, wherein at least one of the plurality of determined timing parameters is determined based at least partly on at least one of: communication delay and processing delay.

4. The system of claim 1, wherein at least one of the plurality of determined timing parameters is determined based at least partly on a latency probability model.

5. The system of claim 1, wherein the networked execution processors comprise exchange servers and the data processing segments represent requests for trades in financial interests.

6. The system of claim 5, wherein the financial interests include at least one of commodities and intangible interests.

7. The system of claim 5, wherein the financial interests include at least one of stocks, bonds, and options.

8. The system of claim 5, wherein the at least one processor is further configured to execute instructions for causing the system to:

associate with each of at least one of the plurality of data processing segments data representing at least one quantity term, the at least one quantity term representing at least one quantity of a financial interest to be traded in accordance with a request represented each of the at least one data processing segments, and at least one corresponding price term associated with each such quantity term, the quantity term representing at least one proposed price at which a trade represented by the at least one data processing segment is to be executed;

the at least one quantity term larger than at least one quantity of the financial interest publicly offered at a price equivalent to the corresponding associated price term, in a market associated with the

networked execution processor(s) to which the at least one data processing segment is to be routed.

9. The system of claim 8, wherein the at least one quantity term is determined based at least partly on a trading history associated with the market associated with the networked execution processor to which the data processing segment is to be routed.

10. A system for causing synchronized processing of data by multiple networked computing resources, the system comprising at least one processor configured to execute machine-interpretable instructions and causing the system to:

monitor execution of signal processing execution requests by each of the plurality of networked computing resources;

determine at least one timing parameter associated with a latency in execution of signal processes between the system and each of the plurality of networked computing resources; and

store the at least one timing parameter in machine-readable memory accessible by the at least one processor.

11. The system of claim 10, wherein the at least one latency is associated with at least one of: communication delay and processing delay.

12. The system of claim 10, wherein the execution of signal processing requests is monitored periodically.

13. The system of claim 10, wherein the execution of signal processing execution requests is monitored continually.

14. The system of claim 10, wherein the networked execution processors comprise exchange servers and the data processing segments represent requests for trades in financial interests.

15. A method of causing synchronized processing of data by multiple networked computing resources, the method performed by at least one processor executing machine-interpretable instructions configured to cause the at least one processor to:

receive from one or more data sources signals representing instructions for execution of at least one data process executable by a plurality of networked computing resources;

divide the at least one data process into a plurality of data processing segments, each data processing segment to be routed to a different one of a plurality of networked execution processors;

based at least partly on latencies in execution of prior data processing requests routed by the system to each of the plurality of networked execution processors, determine a plurality of timing parameters, each of the plurality of timing parameters to be associated with a corresponding one of the plurality of data processing segments, the plurality of timing parameters determined to cause synchronized execution of the plurality of data processing segments by the plurality of networked execution processors; and

using the timing parameters associated with the plurality of data processing segments, route the plurality of data processing segments to the plurality of corresponding networked execution processors.

16. The method of claim 15, wherein the machine-interpretable instructions are further configured to cause the at least one processor to:

associate with each of at least one of the plurality of data processing segments data representing at least one quantity term, the at least

one quantity term representing at least one quantity of a financial interest to be traded in accordance with a request represented each of the at least one data processing segments, and at least one corresponding price term associated with each such quantity term, the quantity term representing at least one proposed price at which a trade represented by the at least one data processing segment is to be executed;

the at least one quantity term larger than at least one quantity of the financial interest publicly offered at a price equivalent to the corresponding associated price term, in a market associated with the networked execution processor(s) to which the at least one data processing segment is to be routed.

17. A method of causing synchronized processing of data by multiple networked computing resources, the method performed by at least one processor executing machine-interpretable instructions configured to cause the at least one processor to:

monitor execution of signal processing execution requests by each of the plurality of networked computing resources;

determine at least one timing parameter associated with a latency in execution of signal processes between the system and each of the plurality of networked computing resources; and

store the at least one timing parameter in machine-readable memory accessible by the at least one processor.

18. A computer-readable medium or media comprising non-transient machine-readable programming structures configured to cause synchronized processing of data by multiple networked computing resources, the programming structures configured to cause at least one processor to:

receive from one or more data sources signals representing instructions for execution of at least one data process executable by a plurality of networked computing resources;

divide the at least one data process into a plurality of data processing segments, each data processing segment to be routed to a different one of a plurality of networked execution processors;

based at least partly on latencies in execution of prior data processing requests routed by the system to each of the plurality of networked execution processors, determine a plurality of timing parameters, each of the plurality of timing parameters to be associated with a corresponding one of the plurality of data processing segments, the plurality of timing parameters determined to cause synchronized execution of the plurality of data processing segments by the plurality of networked execution processors; and

using the timing parameters associated with the plurality of data processing segments, route the plurality of data processing segments to the plurality of corresponding networked execution processors.

19. The medium or media of claim 18, wherein the machine-interpretable instructions are further configured to cause the at least one processor to:

associate with each of at least one of the plurality of data processing segments data representing at least one quantity term, the at least one quantity term representing at least one quantity of a financial interest to be traded in accordance with a request representing each of the at least one data processing segments, and at least one corresponding price term associated with each such quantity term, the quantity term representing at least one proposed price at which a trade represented by the at least one data processing segment is to be executed;

the at least one quantity term larger than at least one quantity of the financial interest publicly offered at a price equivalent to the corresponding associated price term, in a market associated with the networked execution processor(s) to which the at least one data processing segment is to be routed.

20. A computer-readable medium or media comprising non-transient machine-readable programming structures configured to cause synchronized processing of data by multiple networked computing resources, the programming structures configured to cause at least one processor to:

monitor execution of signal processing execution requests by each of the plurality of networked computing resources;

determine at least one timing parameter associated with a latency in execution of signal processes between the system and each of the plurality of networked computing resources; and

store the at least one timing parameter in machine-readable memory accessible by the at least one processor.

multiple processors to execute individual portions of multiple-processor execution requests (i.e., execution latencies), in addition to (or as part of) communications latencies.

Summary

[0006a] The invention is defined in the independent claims. Some optional features of the invention are defined in the dependent claims.

[0007] Implementation of the exemplary techniques disclosed herein provide systems, methods, and computer-executable instruction mechanisms (e.g., non-transient machine-readable programming structures) such as software-coded instruction sets and data, for the management of data processing by multiple networked computing resources. In particular, for example, there is provided systems, methods, and coded instruction sets useful in controlling the synchronization of related requests for processing of data using distributed network resources.

[0008] For example, in a first exemplary technique, there is provided systems, methods, and programming or other machine-interpretable instructions for causing synchronized processing of data by multiple networked computing resources, such systems, for example, comprising at least one processor configured to execute machine-interpretable instructions and causing the system to:

> receive from one or more data sources signals representing instructions for execution of at least one data process executable by a plurality of networked computing resources;
>
> divide the at least one data process into a plurality of data processing segments, each data processing segment to be routed to a different one of a plurality of networked execution processors;
>
> based at least partly on latencies in execution of prior data processing requests routed by the system to each of the plurality of networked execution processors, determine a plurality of timing parameters, each of the plurality of timing parameters to be associated with a corresponding one of the plurality of data processing segments, the

plurality of timing parameters determined to cause synchronized execution of the plurality of data processing segments by the plurality of networked execution processors; and

using the timing parameters associated with the plurality of data processing segments, routing the plurality of data processing segments to the plurality of corresponding networked execution processors.

[0009] In some exemplary techniques, as will be explained herein, the networked execution processors can, for example, comprise exchange servers, and the data processing segments represent requests for trades in financial interests such as commodities and/or intangible interests such as stocks, bonds, and/or various forms of options.

[0010] The plurality of determined timing parameters can be used in determining and implementing timing sequences in order to implement desired sequential execution of data processing requests, and can for example represent and/or be based wholly or partially upon latencies in execution of data processing requests due many factors. For example, such parameters can be wholly or partially based on dynamically-monitored latency(ies) in execution of signal processing requests previously routed by the system to at least one of the plurality of networked execution processors. Such latencies may be caused by many factors, including, for example, various types of communication and data processing delays. Such timing parameters may further based on statistical, e.g., probability, models of observed latency data, and patterns therein.

[0011] Such systems, methods, and programming or other machine-interpretable instructions may further be configured such that they cause a system to:

associate with each of at least one of the plurality of data processing segments data representing at least one quantity term, the at least

one quantity term representing at least one quantity of a financial interest to be traded in accordance with a request represented each of the at least one data processing segments, and at least one corresponding price term associated with each such quantity term, the quantity term representing at least one proposed price at which a trade represented by the at least one data processing segment is to be executed;

the at least one quantity term larger than at least one quantity of the financial interest publicly offered at a price equivalent to the corresponding associated price term, in a market associated with the networked execution processor(s) to which the at least one data processing segment is to be routed.

[0012] Such quantity terms can, for example, be determined based at least partly on trading histories associated with the market(s) associated with the networked execution processor(s) to which the data processing segments are to be routed. They can be determined on data relating to displayed or undisplayed offerings and/or trades, including for example historical undisplayed oversize or reserve quantities.

[0013] In other exemplary techniques there is provided systems, methods, and programming or other machine-interpretable instructions for causing synchronized processing of data by multiple networked computing resources, such systems, for example, comprising at least one processor configured to execute machine-interpretable instructions and causing the system to:

monitor execution of signal processing execution requests by each of the plurality of networked computing resources;

determine at least one timing parameter associated with a latency in execution of signal processes between the system and each of the plurality of networked computing resources; and

store the at least one timing parameter in machine-readable memory accessible by the at least one processor.

Monitoring of execution of signal processing execution requests may be implemented on continual, periodic, and/or other suitable or desirable bases.

[0014] The networked computing resources may include one or more exchange servers. The data sources may include one or more broker or trader systems or servers, the controlled signal processes may represent trades in financial interests, and the execution of signal processing execution requests represents the execution of transactions in financial interests, including for example stocks, bonds, options and contract interests, currencies and/or other intangible interests, and/or commodities. The requests for execution of data processing procedures can be based wholly or partially on parameters including, for example, any one or more of current market data quotations, order routing rules, order characteristics, displayed liquidity of each networked computing resource, and a probable delay, or latency, in execution of an order quantity at each networked computing resource.

[0015] In another exemplary technique, there is provided systems for controlling or otherwise managing requests for processing of data by distributed computer resources, such systems including one or more processors configured to execute instructions for causing the system to:

monitor execution of signal processing execution requests by each of the plurality of networked computing resources;

determine at least one timing parameter associated with the latency in execution of signal processes between the system and each of the plurality of networked computing resources; and

store the at least one timing parameter for each of the plurality of networked computing resources

[0016] Therefore it may be possible to monitor latencies and other factors in networked processing of multipart or other complex data processing requests on a dynamic, or 'rolling', basis, and using such dynamically-monitored latencies and/or other factors in determining timing parameters to be used in implementing synchronized processing requests, as disclosed herein. Timing parameters used in implementing synchronized processing requests can be monitored and/or determined on continuous, continual, periodic, or other bases, depending upon the needs, objectives, and other factors of the applications in which they are to be applied.

[0017] Implementation of the exemplary techniques disclosed herein may reduce or eliminate the need for consideration of one-way communications latencies, e.g., the need to minimize latencies in communications between routing and execution processors.

[0018] As will be appreciated by those skilled in the relevant arts, once they have been made familiar with this disclosure, synchronization of execution of distributed data processing requests by, for example, synchronized transmission of requests for such processing, has a great many possible applications in a large number of data processing fields.

Brief Description of the Drawings

[0019] Reference will now be made to the drawings, which show by way of example embodiments of the present disclosure.

[0020] FIGS. 1A, IB, and 3 show examples of systems suitable for causing processing of data by multiple networked computing resources in accordance with various aspects of the invention.

[0031] Networked computing resources 106 may include any devices or other resources that communicate with router processor(s) 104 to receive and carry out any of a very wide variety of data processing requests. Such networked computing resources 106 may include systems, servers, processors or any other suitable devices adapted for execution of any processes suitable for use in the exemplary techniques disclosed herein, including, for example, processing of offers or bids for purchase of commodities, financial interests, etc., and/or other data processing tasks, such as word or document processing, image, and/or other communications or documentation tasks.

[0032] In various embodiments, the one or more data sources 102 transmit or otherwise provide to or for the router processor(s) 104 signals representing instructions, or requests, for executing data processing functions. Instructions from any given data source(s) 102 may include instructions for signal processes to be executed by any one or more networked computing resources 106. Requested signal processes may include, for example, computing operations, data manipulations, and/or communications processes or other signal exchanges, among others. In some but not necessarily all examples, such instructions may specifically identify networked computing resource(s) 106 particularly targeted for execution of such processes.

[0033] Router processor(s) 104 may parse instruction signals received from one or more source(s) 102 and use such signals to prepare instructions, or requests, to be forwarded to pluralities of execution processors 106, for execution of data processing and/or other signal processes in accordance with the received instructions. Parsing of such instructions may include, for example, identifying the type of process(es) to be requested, including for example the volume or quantity of an order or bid for a trade or an amount of document processing to be done, and the type, nature, and/or identity(ies) of networked computing resource(s) 106 to be requested to

[0036] As a further example, single instruction sets for processing of data may be broken down by processor(s) 104 and distributed to a plurality of resources 106 for distributed execution. For example, a relatively large order for trading in one or more financial interests originating from a single source 102a, 102b, might need to be distributed to multiple exchange servers 106 in order to be completely filled; in such cases request(s) from one or more source(s) 102 may be broken down by processor(s) 104 into suitable orders for execution by a plurality of such resources 106.

[0037] Targeted, or specifically identified, networked computing resources / execution processors 106 communicate with the router processor(s) 104 to receive the segmented signal process execution requests and may thereafter execute them accordingly. Execution of such signal processes may include, for example, carrying out a text- or image-processing operation, a mathematical computation, or a communications signal exchange, among others.

[0038] As will be readily understood by those skilled in the relevant arts, various components of system 100 may combined, or may be implemented in the form of separate systems or devices. In a wide variety of configurations, such combined or separate (sub)systems may be operated by the same or distinct entities. As a particular example, one or more request source(s) 102 may be integrated with, or otherwise associated with, individual router(s) 104.

[0039] An example of an application of a system 100 for distributed execution of segmented processing requests is provided by a financial system 1000 adapted for processing of requests for processing of data representing trades and/or offers for trades, or other transactions, in tangible and/or intangible financial interests such as stocks, bonds, currencies (e.g., foreign exchange), various forms of natural resources or commodities, options, loans, etc. As shown in Figures 1A and IB, for example, in a financial transaction data processing system 1000,

signal or data source(s) 102 may include trader system(s) 1102, which may, for example, include trader/broker systems or servers as well as any other sources of bids, offers, or other transactions in financial interests such as currently provided by known financial trading platforms. In various embodiments, such trader systems 1102 may be referred to as order origination systems.

[0040] Order origination systems 1102, 102a may include systems operated by or on behalf of, for example, entities owned or otherwise controlled by parent or other controlling organizations such as banks or brokerage houses. Order origination systems 1102, 102b may, for example, include systems operated by or on behalf of brokers or other trading entities acting on behalf of, for example, individual investors, trading through or with the assistance of independently-controlled banks, institutional investors, and/or other brokerage houses.

[0041] Router processor(s) 104 in such embodiments may include, for example, server(s) or other system(s) 1104 that communicate with trader systems 1102, 102, for example through the receipt and transmission of encoded electronic signals representing requests for processing of data representing execution and/or acknowledgement of transactions in financial interests; and which communicate with broker, exchange, or other market systems or execution processor(s) 1106 for execution of such transactions. In such embodiments a processor 104 may be referred to as a Smart Order Router or Tactical Hybrid Order Router (in either case, "SOR") 1104, 104. An SOR 1104 may, for example, include one or more gateway(s) 1122 and/or router(s) 1124 for facilitating communications by router(s) 1104 with one or more trader systems 1102, 102 directly (e.g., through wired communication, using one or more dedicated communication channel(s), or through communication within a single server) and/or indirectly (e.g., through wireless communication, through a network 108, 1108 or through an intermediate server). Exchange or market systems 1106, or other execution processor(s) 106 may be in communication with SOR(s) 1104 through, for

segment thereof, or any other desired time period(s), which may be preset and/or dynamically determined by processor(s) 104, 1104. Instructions may be also be processed individually, as received. If more instructions are to be received prior to processing, or may potentially be received, process 200 can return to 202.

[0055] Transaction requests / instructions may be accumulated during defined time intervals, such as the duration of a business day or any segment thereof, or a desired time period, which may be preset and/or dynamically determined by processor(s) 104, 1104. If more instructions to be received, or may potentially be received, process 200 can return to 202.

[0056] In techniques which employ sorting / aggregation techniques in parsing or otherwise preparing order or other processing requests, at 206 processor(s) 104, 1104 can repeat process 202 - 204 until all needed or desired related or aggregatable processing request signal sets have been received from source(s) 102, 1102. For example, as described above, arbitrary numbers of data records representing orders or requests for purchase of bonds identifiable by CUSIP (Committee on Uniform Security Identification Procedures) numbers can be received from data source(s) 102, 1102, and stored in memory 118, 1018 associated with the processor(s) 104, 1104, for batch processing, thus:

<source l><sell><CUSIP No. AA>< l0,000><price A>< res. 9,000> <price D>
<source 2> <buy><CUSIP No. BB>< l2,000><price C><res. l,000><price B>
<source 3> <sell><CUSIP No. BB>< l1,000><price A><res. 8,000> <price D>
<source 6> <sell><CUSIP No. AA>< l4,000><price A><res. 2,000> <price E>
<source 4> <buy><CUSIP No. AA>< l8,000><price C><res. 7,000><price B>
<source l><sell><CUSIP No. BB><20,000><price A><res. 3,000><price D>
<source 3> <sell><CUSIP No. AA>< l3,000><price A>< res. 6,000><price D>
<source 4> <buy><CUSIP No. BB><22,000><price C><res. 4,000><price B>
<source 5> <sell><CUSIP No. AA><21,000><price A>< res. 5,000><price E>
<source 4> <buy><CUSIP No. BB>< l5,000><price C><res. 7,000> <price F>
<source l><sell><CUSIP No. AA>< l9,000><price A><res. 3,000> <price D>
<source 5> <buy><CUSIP No. BB>< l6,000><price C><res. 8,000> <price F>
<source 6> <sell><CUSIP No. BB>< l7,000><price A><res. 6,000> <price H >

[0057] Upon individual receipt, or at a given periodic rate, a given time, when a given number of orders has been received, when all desired orders have

<buy><CUSIP No. BB><65,000><price C><res. 15,000><price E>

<res. 5,000><price B>

<sell><CUSIP No. BB><48,000><price A><res. 11,000><price D>

<res. 6,000><price H>

[0059] When all desired signal sets have been received at 202, and optionally sorted, accumulated, and/or otherwise processed at 204, at 208 processor(s) 104, 1104, using instruction sets processed at 204, can prepare execution-request signal sets for transmission to resources / execution processors 106, 1106. Such execution-request signal sets can comprise any necessary or desirable signals for causing requested processing, including content or data and command signals. For example, when adapted for processing of requests for transactions in financial interests, requests may be sorted and/or aggregated on the basis of interest(s) to be traded, quantities of interest(s) to be traded, price, etc., and associated with suitable execution command signals. The form of any execution command signals associated with a given request can depend, as those skilled in the relevant arts will recognize, on the nature and type of requests to be executed and the processors 106, 1106 by which they are to be executed, as well any networks 110, 1110 over which signals exchanged between processor(s) 104, 1104 and 106, 1106 are to be sent, including applicable protocols and instruction formatting requirements. Ergo, data pertaining to any or all of systems 106, 1106, 104, 1104, and 110, 1110, protocols used thereby, and/or information related to interests traded, offered, or described thereby may be accessed and used by processor(s) 104, 1104 in parsing and preparing instructions for execution of processing by any of processors or resources 106, 1106. Sources 1126 of such data may include, for example, exchange market data system 1126v (Figure lb) which, for example, when adapted for processing of financial transactions, can include information received from various exchange systems 1106, news information sources such as Bloomberg or Reuters, and/or other sources.

[0060] It is sometimes necessary or desirable, in assembling requests for data processing using networked processing resources, including many resources configured for use in executing financial transactions, to break execution and/or other processing requests into multiple parts. Such parts, or segments, can, for example, correspond to portions of larger orders or other data processing requests, to be executed by a plurality of networked resources 106 such as exchange servers or other execution processor or handlers 1106. For example, if a plurality of exchange servers or other markets are available for execution of a transaction request representing a purchase order for a significant amount of a financial interest such as a stock or bond, it may be necessary or desirable to split the order into multiple parts, for execution in multiple markets and/or by multiple exchange servers 1106. For example, sufficient quantities of specific interests may not be available, at all or at desirable prices, on a single exchange: in order to fill an order entirely, it may be necessary or desirable to break a single order into smaller segments and route it to multiple exchanges.

[0061] Thus, for example, when directed toward the processing of requests for transactions in financial instruments, when a router 104,1104 is requested by one or more sources 106, 1106 to complete a transaction in one or more financial interests, the router 104, 1104 can, in preparing signal set(s) representing requests for the transactions, access information available from sources such as market data source(s) 1126, as well as any one or more execution processor(s) 106, 1106, to determine the quantities of such interests available through the respective processors 106, 1106 and the terms under which such quantities are available, and can construct an execution request signal set configured for routing to each of the respective desired processors 1106, 1106, based on the number of quantities available at the most favorable terms.

[0062] For example, continuing the example above, it may be necessary or desirable to split one or more incoming processing requests into smaller parts, directed to a plurality of exchanges, in order to obtain fulfillment of the

synchronize the execution of signal processing execution requests, or portions or segments thereof, in multiple networked computing resources 106, 1106, for example such that the signal processes are received, acknowledged, and/or executed by the resources 106, 1106 in a substantially concurrent manner.

[0071] In some examples it may not be necessary for the signal processes to be executed in each processor 106, 1106 to be executed simultaneously, but may be sufficient that:

Time Y - Time X < Time A, and/or
Time Z - Time X < Time B,

such that execution of the request(s) or segments thereof occurs before any change in terms can be implemented by a trading server 304. The use of such synchronized timings can, for example, cause:

Time X + Time A > Time Y and/or
Time X + Time B > Time Z

and thus, for example, defeat latency arbitrage opportunities. In some uses, therefore, this may provide router(s) 104, 1104 the ability to execute transactions across multiple resources 106, 1106 with minimal or no time variance, such that algorithms run by trader(s) 304 employing low-latency algorithms are given insufficient time to react to market changes.

[0072] Thus, in these and other cases where synchronization is desired, at 210 processor / router 104, 1104 can determine absolute or relative timings to be assigned to, or otherwise associated with, various portions or segments of an execution request, in order to obtain the desired sequencing. Such timings can be determined in order to cause any desired synchronization : for example, timings configured to cause simultaneous, or substantially

[00104] As will be readily understood by those skilled in the relevant arts, systems 100, 1000 can comprise devices or components suitable for providing a wide variety of further metrics and functionalities. For example, reference is now made to FIG. 7, which illustrates two examples of the provision by a routing processor 104, 1104 or other processor of a benchmark comparison relative to a market average price provided by, for example, a market news service or other market data source 1126v. At 646, performance of a system 100, 1000 in synchronized processing of a multipart transaction request is compared to a market performance indicator "Average Price Benchmark." Such average price benchmark, or other benchmark or metric factor, can be obtained from, for example, any or all of components 1126, 1106, etc. At 644, performance of a system 100, 1000 in un-synchronized processing of a multi-part transaction request in accordance with prior art methods is compared to the same market performance indicator "Average Price Benchmark." Comparison of comparisons 646, 644 indicates that processing of transactions provides better results for a seller of financial interests. As will be understood by those skilled in the relevant arts, a wide variety of benchmarks may be used in assessing performance of systems and methods according to the invention. Such benchmarks may be determined at least partially by the nature of the system 100, 1000 used, and the types of transactions or other execution requests processed by such system.

[00105] In the embodiment shown in Figure IB, source(s) 1126 of data useable by processor(s) 104 in preparing financial transaction or other data processing execution requests includes a plurality of modules 1126a-g useful in preparing a multi-part execution request. In the example shown, modules 1126a-g include market data processing module 1126a, exchange round-trip latency measurement module 1126b, adaptive exchange round-trip latency (RTL) learning & compensation logic module 1126c, smart sweeping share allocation logic module 1126d, smart posting logic module 1126e, regional & national exchange access logic module 1126f, and aggressiveness management module 1126g.

CLAIMS

1. A device comprising at least one processor configured to:

associate, with signals representing instructions for execution of a plurality of portions of a data process executable by a plurality of networked computing resources, the data process representing a plurality of proposed transactions in one or more financial interests, at least one timing parameter determined at least partly using one or more latencies associated with execution of signal processing requests by at least one of the networked computing resources; and

using the at least one associated timing parameter, route the signals representing instructions for execution of the plurality of portions of the plurality of proposed transactions to a plurality of networked computer resources;

determine the at least one associated timing parameter so as to cause synchronized arrival of the signals representing instructions for execution of the plurality of portions of the plurality of proposed transactions by the plurality of networked computer resources.

2. The device of claim 1, configured for the at least one timing parameter to be determined based at least partly on dynamically-monitored latency in execution of signal processing requests routed to at least one of the plurality of networked computing resources.

3. The device of claim 1, configured for the at least one timing parameter to be determined based at least partly on statistical latency in execution of signal processing requests routed to at least one of the plurality of networked computing resources.

4. The device of claim 1, configured for the at least one timing parameter to be determined based at least partly on historical latency in execution of signal processing requests routed to at least one of the plurality of networked computing resources.

5. The device of claim 1, configured for the at least one timing parameter to be determined based at least partly on predictive latency in execution of signal processing requests routed to at least one of the plurality of networked execution processors.

6. The device of claim 1, configured for the at least one timing parameter to be determined such that the synchronized arrival is simultaneous.

7. The device of claim 1, configured for the at least one timing parameter to be determined such that the synchronized arrival is according to a non-simultaneous sequence.

8. The device of claim 1, configured for the at least one timing parameter to be determined such that the synchronized arrival is according to a determined relative timing.

9. The device of claim 1, configured for the at least one timing parameter to be determined based at least partly on at least one of: communication delay or processing delay.

10. The device of claim 1, configured for the at least one timing parameter to be determined based at least partly on a latency probability model.

11. The device of claim 1, wherein the financial interests include at least one of commodities or currency interests.

12. The device of claim 1, wherein the financial interests include at least one of equity or non-equity interests, or derivatives thereof.

13. A method performed by at least one data processor, comprising:

associating, with signals representing instructions for execution of a plurality of portions of a data process executable by a plurality of networked computing resources, the data process representing a plurality of proposed transactions in one or more financial interests, at least one timing parameter determined at least partly using one or more latencies associated with execution of signal processing requests by at least one of the networked computing resources; and

using the at least one associated timing parameter, route the signals representing instructions for execution of the plurality of portions of the plurality of proposed transactions to a plurality of networked computer resources;

the at least one associated timing parameter determined so as to cause synchronized arrival of the signals representing instructions for execution of the plurality of portions of the plurality of proposed transactions by the plurality of networked computer resources.

14. The method of claim 13, wherein the at least one timing parameter is determined based at least partly on dynamically-monitored latency in execution of signal processing requests routed to at least one of the plurality of networked computing resources.

15. The method of claim 13, wherein the at least one timing parameter is determined based at least partly on statistical latency in execution of signal processing requests routed to at least one of the plurality of networked computing resources.

16. The method of claim 13, wherein the at least one timing parameter is determined based at least partly on historical latency in execution of signal processing requests routed to at least one of the plurality of networked computing resources.

17. The method of claim 13, wherein the at least one timing parameter is determined based at least partly on predictive latency in execution of signal processing requests routed to at least one of the plurality of networked computing resources.

18. The method of claim 13, wherein the at least one timing parameter is determined such that the synchronized arrival is simultaneous.

19. The method of claim 13, wherein the at least one timing parameter is determined such that the synchronized arrival is according to a non-simultaneous sequence.

20. The method of claim 13, wherein the at least one timing parameter is determined such that the synchronized arrival is according to a determined relative timing.

21. A computer-readable medium or media comprising non-transient machine-readable programming structures configured to cause at least one processor to:

associate, with signals representing instructions for execution of a plurality of portions of a data process executable by a plurality of networked computing resources, the data process representing a plurality of proposed transactions in one or more financial interests, at least one timing parameter determined at least partly using one or more latencies associated with execution of signal processing requests by at least one of the networked computing resources; and

using the at least one associated timing parameter, route the signals representing instructions for execution of the plurality of portions of the plurality of proposed transactions to a plurality of networked computer resources;

determine the at least one associated timing parameter so as to cause synchronized arrival of the signals representing instructions for execution of the plurality of portions of the a plurality of proposed transactions by the plurality of networked computer resources.

22. The medium or media of claim 21, configured for the at least one timing parameter to be determined based at least partly on dynamically-monitored latency in execution of signal processing requests routed to at least one of the plurality of networked computing resources.

23. The medium or media of claim 21, configured for the at least one timing parameter to be determined based at least partly on statistical latency in execution of signal processing requests routed to at least one of the plurality of networked computing resources.

24. The medium or media of claim 21, configured for the at least one timing parameter to be determined based at least partly on historical latency in execution of signal processing requests routed to at least one of the plurality of networked computing resources.

25. The medium or media of claim 21, configured for the at least one timing parameter to be determined based at least partly on predictive latency in execution of signal processing requests routed to at least one of the plurality of networked computing resources.

26. The medium or media of claim 21, configured for the at least one timing parameter to be determined such that the synchronized arrival is simultaneous.

27. The medium or media of claim 21, configured for the at least one timing parameter to be determined such that the synchronized arrival is according to a non-simultaneous sequence.

28. The medium or media of claim 21, configured for the at least one timing parameter to be determined such that the synchronized arrival is according to a determined relative timing.