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(54) Title: A UNIQUE APPROACH TO DETERMINISTICALLY TRANSMIT DATA FROM POINT TO POINT

(57) Abstract: A method of scheduling transmission for a plurality of communication packets is disclosed. The method may include receiving a plurality of communication packets having a plurality of associated cycle times. The method may further include determining a common time width for transmitting the plurality of communication packets based on the plurality of associated cycle times. The method may further include distributing the plurality of communication packets in a Table including a plurality of slots. Each communication packet of the plurality communication packets may be allocated a unique slot in the Table, and each slot may accommodate a single communication packet of the plurality communication packets

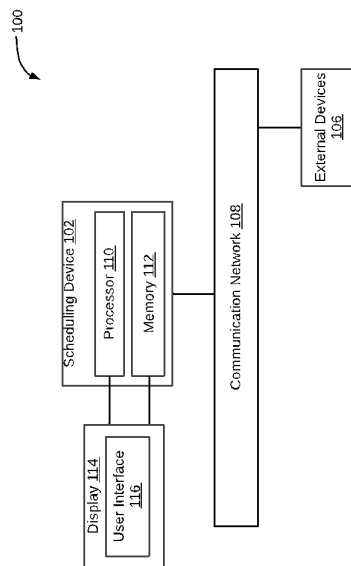


FIG. 1

FORM 2

THE PATENTS ACT 1970
(39 OF 1970)
&
The Patent Rules, 2003
Complete Specification
(See Section 10 and Rule 13)

1. TITLE OF THE INVENTION

A Unique Approach To Deterministically Transmit Data From Point To Point

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3. PREAMBLE TO THE DESCRIPTION

COMPLETE

The following specification particularly describes the invention and the manner in which it is performed.

DESCRIPTION

Technical Field

[001] This disclosure relates generally to transmission of data, and in particular to a method of scheduling transmission for a plurality of communication packets.

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BACKGROUND

[002] In real time applications, there are different communication buses that are used to communicate information at periodic interval or are event driven to connected devices and external world. The communication happens through defined standard protocols (for example SPI, CAN, ARINC429) or native protocol. The information is divided into packets with identification, validity and periodicity. As the project matures, information to be communicated may increase and new packets may get introduced into system. As a result, complexity may increase in terms of processing logic, aligning to periodicity, and communication bandwidth utilization.

[003] The transmission of communication packets may be scheduled depending on task timing. For example, application task timings may be 1 millisecond (ms), or 5 ms, or 10 ms, or 100 ms, etc. It may be understood that communication transmission routines may be invoked at the end of current cycles or at the beginning of next cycles. Although the communication may be spread across different tasks to reduce the task load, at some point in time when task meets the multiples of the number, there may be intersection. In the above example, a 5 ms task at its 20th cycle may intersect a 100 ms task. Similarly, a 10 ms task at its 10th cycle may intersect the 100 ms task at one of its cycle. So, at the point of intersection. load on communication may become significantly high. Further, chances of missing packets or dropping packets also becomes higher. As a result, the performance and reliability of the product and/or overall system is impacted.

[004] Therefore, a technique of scheduling transmission is desired that overcomes the above problems due to communication overload occurring at a transmission intersection points.

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SUMMARY OF THE INVENTION

[005] In an embodiment, a method of scheduling transmission for a plurality of communication packets is disclosed. The method may include receiving a plurality of communication packets
5 having a plurality of associated cycle times. The method may further include determining a common time width for transmitting the plurality of communication packets based on the plurality of associated cycle times. The method may further include distributing the plurality of communication packets in a Table including a plurality of slots. Each communication packet of the plurality communication packets may be allocated a unique slot in the Table, and each slot may
10 accommodate a single communication packet of the plurality communication packets.

BRIEF DESCRIPTION OF THE DRAWINGS

[006] The accompanying drawings, which are incorporated in and constitute a part of this disclosure, illustrate exemplary embodiments and, together with the description, serve to explain the disclosed principles.

15 [007] **FIG. 1** is a block diagram of a system for scheduling transmission for a plurality of communication packets, in accordance with an embodiment of the present disclosure.

[008] **FIG. 2** illustrates an exemplary Table for scheduling a plurality of communication packets, in accordance with an embodiment.

20 [009] **FIG. 3** illustrates another exemplary Table for scheduling a plurality of communication packets, in accordance with an embodiment.

DETAILED DESCRIPTION OF THE DRAWINGS

[010] Exemplary embodiments are described with reference to the accompanying drawings. Wherever convenient, the same reference numbers are used throughout the drawings to refer to the same or like parts. While examples and features of disclosed principles are described herein,
25 modifications, adaptations, and other implementations are possible without departing from the spirit and scope of the disclosed embodiments. It is intended that the following detailed description

be considered as exemplary only, with the true scope and spirit being indicated by the following claims. Additional illustrative embodiments are listed below.

5 [011] Referring to FIG. 1, a block diagram of an exemplary system 100 for scheduling transmission for a plurality of communication packets is illustrated, in accordance with an embodiment of the present disclosure. The system 100 may include a scheduling device 102, which may be a server, desktop, laptop, notebook, netbook, tablet, smartphone, mobile phone, or any other computing device.

10 [012] The scheduling device 102 may receive a plurality of communication packets having a plurality of associated cycle times. It may be noted that the associated cycle times for a communication packet may indicate a cycle time (frequency) at which a communication packet corresponding to the communication packet may be transmitted. For example, for a packet P(100,1) having a cycle time of 100 milliseconds, a communication packet corresponding to this packet is to be transmitted every 100 milliseconds.

15 [013] The scheduling device 102 may further determine a common time width for transmitting the plurality of communication packets. In some embodiments, it may be noted that the common time width may be based on a highest common factor of the plurality of associated cycle times. The scheduling device 102 may further distribute the plurality of communication packets in a Table comprising a plurality of slots. Each communication packet of the plurality communication packets may be allocated a unique slot in the Table. Further, a slot may accommodate only a single
20 communication packet. In other words, no two communication packets may be allocated a single slot in the Table.

[014] In order to perform the above functionalities, the scheduling device 102 may include one or more processors 110, a computer-readable medium (for example, a memory) 112, and a display 114. The computer-readable storage medium 112 may store instructions that, when executed by
25 the one or more processors 110, cause the one or more processors 110 to schedule transmission for a plurality of communication packets, in accordance with aspects of the present disclosure. The computer-readable storage medium 112 may also store various data that may be captured, processed, and/or required by the system 100. The system 100 may interact with a user via a user

interface 116 accessible via the display 114. The system 100 may also interact with one or more external devices 106 over a communication network 108 for sending or receiving various data. The external devices 106 may include, but may not be limited to, a remote server, a digital device, or another computing system.

5 **[015]** Referring now to FIG. 2, a Table 200 for scheduling a plurality of communication packets is illustrated, in accordance with an embodiment. The Table 200 may include a plurality of slots to which a plurality of communication packets may be allocated. For example, the plurality of communication packets may include a first communication packet P(100,1) having an associated cycle time 100 ms, a second communication packet P(50,1) having an associated cycle time 50 ms,
10 a third communication packet P(20,1) having an associated cycle time 20 ms, a fourth communication packet P(50,2) having an associated cycle time 50 ms, a fifth communication packet P(100,2) having an associated cycle time 100 ms, a sixth communication packet P(50,3) having an associated cycle time 50 ms, and so on.

[016] As such, communication packets corresponding to the first communication packet
15 P(100,1), the fifth communication packet P(100,2), eighth communication packet P(100,3) and the ninth communication packet P(100,4) may have a cycle time of 100 ms, i.e. they may be repeated every 100 ms. Similarly, communication packets corresponding to the second communication packet P(50,1), fourth communication packet P(50,2), sixth communication packet P(50,3) and the seventh communication packet P(50,4) may have a cycle time of 50 ms, i.e. they may be repeated
20 every 50 ms. Further, communication packets corresponding to the third communication packet P(20,1) may have a cycle time of 20 ms, i.e. they may be repeated every 20 ms. Communication packets corresponding to tenth, eleventh, and twelfth communication packets P(200,1), P(200,2) and P(200,3) respectively may have a cycle time of 200ms, i.e. they may be repeated every 200 ms. Communication packets corresponding to thirteenth, fourteenth, and fifteenth communication
25 packets P(400,1), P(400,2) and P(400,3) respectively may have a cycle time of 400 ms, i.e. they may be repeated every 400 ms. Communication packets corresponding to sixteenth, seventeenth, eighteenth, nineteenth, twentieth, and twenty first communication packets P(800,1), P(800,2), P(800,3), P(800,4), P(800,5) and P(800,6) respectively may have a cycle time of 800 ms, i.e they may be repeated every 800 ms.

[017] A common time width may be determined for transmitting the plurality of communication packets. The common time width may be determined based on the plurality of associated cycle times. In the above example, the common time width may be set to 5 ms. Accordingly, the Table 200 may include multiple slots separated by 5 ms, as indicated by the row 202.

5 **[018]** Accordingly, for a first cycle, the first communication packet P(100,1) may be allocated the 1st slot, i.e. slot in the 1st row and 1st column (R1, C1). The second communication packet P(50,1) may be allotted the 2nd slot (R1, C2), the third communication packet P(20,1) may be allotted a 3rd slot (R1, C3), the fourth communication packet P(50,2) may be allotted a 4th slot (R1, C4), the 5th communication packet P(100,2) may be allotted a 5th slot (R1, C5), the sixth
10 communication packet P(50,3) may be allotted a 6th slot (R1, C6), a seventh communication packet P(50,4) may be allotted a 8th slot (R1, C8), an eighth communication packet P(100,3) may be allotted a 9th slot (R1, C9), a ninth communication packet P(100,4) may be allotted a 10th slot (R1, C10), a tenth communication packet P(200,1) may be allotted to a 13th slot (R1, C13), an eleventh communication packet P(200,2) may be allotted to a 17th slot (R1, C17), a twelfth communication
15 packet P(200,3) may be allotted to a 20th slot (R1, C20), a thirteenth communication packet P(400,1) may be allotted to a 33rd slot (R2, C13), a fourteenth communication packet P(400,2) may be allotted to a 37th slot (R2, C17), a fifteenth communication packet P(400,3) may be allotted to a 40th slot (R2, C20), a sixteenth communication packet P(800,1) may be allotted to 73rd slot (R4, C13), a seventeenth communication packet P(800,2) may be allotted to 77th slot (R4, C17), an
20 eighteenth communication packet P(800,3) may be allotted to 80th slot (R4, C20), a nineteenth communication packet P(800,4) may be allotted to 153rd slot (R8, C13), a twentieth communication packet P(800,5) may be allotted to 157th slot (R8, C17), and a twenty first communication packet P(800,6) may be allotted a 160th slot (R8, C20).

25 **[019]** For a second cycle, the first communication packet P(100,1) may be allocated a 21st slot (R2, C1), the second communication packet P(50,1) may be allotted an 12th slot (R1, C12), the third communication packet P(20,1) may be allotted a 7th slot (R1, C7), the fourth communication packet P(50,2) may be allotted a 14th slot (R1, C14), the fifth communication packet P(100,2) may be allotted a 25th slot (R2, C5), the sixth communication packet P(50,3) may be allotted a 16th slot (R1, C16), the seventh communication packet P(50,4) may be allotted an 18th slot (R1, C18), the

eighth communication packet P(100,3) may be allotted a 29th slot (R2, C9), the ninth communication packet P(100,4) may be allotted a 30th slot (R2, C10), the tenth communication packet P(200,1) may be allotted to a 53rd slot (R3, C13), the eleventh communication packet P(200,2) may be allotted to a 57th slot (R3, C17), the twelfth communication packet P(200,3) may be allotted to a 60th slot (R3, C20), the thirteenth communication packet P(400,1) may be allotted to a 113th slot (R6, C13), the fourteenth communication packet P(400,2) may be allotted to a 117th slot (R6, C17), and the fifteenth communication packet P(400,3) may be allotted to a 120th slot (R6, C20). Further, (not shown in the Table 200) the sixteenth communication packet P(800,1) may be allotted to 233rd slot (R12, C13), the seventeenth communication packet P(800,2) may be allotted to 237th slot (R12, C17), the eighteenth communication packet P(800,3) may be allotted to 240th slot (R12, C20), the nineteenth communication packet P(800,4) may be allotted to 313th slot (R16, C13), the twentieth communication packet P(800,5) may be allotted to 317th slot (R16, C17) and the twenty first communication packet P(800,6) may be allotted a 320th slot (R16, C20). The process may be repeated for the subsequent cycles.

15 **[020]** In this way, it may be noted, that each communication packet of the plurality communication packets is allocated a unique slot in the Table 200, and no slot in the Table 200 accommodates more than one communication packet. Therefore, only one communication packet is transmitted at any one point of time, and no two communication packets are transmitted at any one point of time, thereby avoiding data overloading.

20 **[021]** Referring now to FIG. 3, a Table 300 for scheduling a plurality of communication packets is illustrated, in accordance with another embodiment. The Table 300 may include a plurality of slots to which a plurality of communication packets may be allocated. For example, the plurality of communication packets may include a first communication packet P (5,1) having an associated cycle time 5 ms, a second communication packet P (10,1) having an associated cycle time 10 ms, a third communication packet P (10,2) having an associated cycle time 10 ms, a fourth communication packet P (10,3) having an associated cycle time 10 ms, a fifth communication packet P (15,1) having an associated cycle time 15 ms, a sixth communication packet P (15,2) having an associated cycle time 15 ms, a seventh communication packet P (20,1) having an associated cycle time 20 ms, an eighth communication packet P (20,2) having an associated cycle

time 20 ms, a ninth communication packet P (30,1) having an associated cycle time 30 ms, a tenth communication packet P(30,2) having an associated cycle time 30 ms, an eleventh communication packet P(30,3) having an associated cycle time 30 ms, a twelfth communication packet P(50,1) having an associated cycle time 50 ms, a thirteenth communication packet P(50,2) having an associated cycle time 50 ms, fourteenth communication packet P(50,3) having an associated cycle time 50 ms, fifteenth communication packet P(60,1) having an associated cycle time 60 ms, sixteenth communication packet P(60,2) having an associated cycle time 60 ms, seventeenth communication packet P(60,3) having an associated cycle time 60 ms, eighteenth communication packet P(60,4) having an associated cycle time 60 ms, nineteenth communication packet P(100,1) having an associated cycle time 100 ms, twentieth communication packet P(100,2) having an associated cycle time 100 ms and twenty first communication packet P(100,3) having associated cycle time 100 ms.

[022] The common time width in the above example may be set to 1 ms. Accordingly, the Table 300 may include multiple slots separated by 1 ms. Accordingly, for a first cycle, the first communication packet P (5,1) may be allocated the 1st slot (R1, C1). The second communication packet P (10,1) may be allocated the 2nd slot (R1,C2). The fifth communication packet P (15,1) may be allocated the 3rd slot (R1,C3). The ninth communication packet P (30,1) may be allocated the 4th slot (R1,C4). The seventh communication packet P (20,1) may be allocated the 5th slot (R1,C5). The third communication packet P (10,2) may be allocated the 7th slot (R1,C7). The sixth communication packet P (15,2) may be allocated the 8th slot (R1,C8). The fourth communication packet P (10,3) may be allocated the 9th slot (R1,C9). The twelfth communication packet P (50,1) may be allocated the 10th slot (R1,C10). The fifteenth communication packet P (60,1) may be allocated the 13th slot (R2,C3). The tenth communication packet P (30,2) may be allocated the 14th slot (R2, C4). The eighth communication packet P (20,2) may be allocated the 15th slot (R2, C5). The nineteenth communication packet P (100,1) may be allocated the 20th slot (R2, C10). The eleventh communication packet P (30,3) may be allocated to 24th slot (R2, C4). The seventeenth communication packet P (60,3) may be allocated to 28th slot (R3, C8). The thirteenth communication packet P (50,2) may be allocated to 30th slot (R3, C10). The twentieth communication packet P (100, 2) may be allocated to 40th slot (R4, C10). The sixteenth communication packet P (60, 2) may be allocated to 43rd slot (R5, C3). The fourteenth

communication packet P (50, 3) may be allocated to 50th slot (R5, C10). The eighteenth communication packet P (60, 4) may be allocated to 58th slot (R6, C8). The twenty first communication packet P(100,3) may be allocated to 70th slot (R7, C10) Accordingly, the process may be repeated for the subsequent cycles.

5 **[023]** Accordingly, for a second cycle, the first communication packet P (5,1) may be allocated the 6th slot (R1,C6). The second communication packet P (10,1) may be allocated the 12th slot (R2,C2). The fifth communication packet P (15,1) may be allocated the 18th slot (R2,C8). The ninth communication packet P (30,1) may be allocated the 34th slot (R4,C4). The seventh communication packet P (20,1) may be allocated the 25th slot (R2,C5). The third communication packet P (10,2) may be allocated the 17th slot (R2,C7). The sixth communication packet P (15,2) may be allocated the 23rd slot (R3,C3). The fourth communication packet P(10,3) may be allocated the 19th slot (R2,C9). The twelfth communication packet P(50,1) may be allocated the 60th slot (R6,C10). The fifteenth communication packet P(60,1) may be allocated the 73th slot (R8,C3). The tenth communication packet P(30,2) may be allocated the 44th slot (R5,C4). The eighth communication packet P(20,2) may be allocated the 35th slot (R4,C5). The nineteenth communication packet P(100,1) may be allocated the 120th slot (R12,C10). The eleventh communication packet P(30,3) may be allocated to 54th slot (R6,C4). The seventeenth communication packet P(60,3) may be allocated to 88th slot (R9,C8). The thirteenth communication packet P(50,2) may be allocated to 80th slot (R13,C10). The twentieth communication packet P(100,2) may be allocated to 140th slot (R14,C10). The sixteenth communication packet P(60,2) may be allocated to 103rd slot (R11,C3). The fourteenth communication packet P(50,3) may be allocated to 100th slot (R10,C10). The eighteenth communication packet P(60,4) may be allocated to 118th slot (R12,C8). The twenty first communication packet P(100,3) may be allocated to 170th slot (R17,C10).

25 **[024]** In this way, again, each communication packet is allocated a unique slot in the Table 300, and no slot in the Table 300 accommodates more than one communication packet, and only one communication packet is transmitted at any one point of time, and no two communication packets are transmitted at any one point of time, thereby avoiding data overloading.

[025] One or more techniques of scheduling transmission for a plurality of communication packets are disclosed. The techniques may be applied on CAN communication, or any serial communication that includes of packets, in which packets are transmitted periodically. The techniques provide for a table-based scheduling. The table is split into lowest task precision, and communication packets are distributed, such that at no given point in time, tasks are overloaded.

[026] The techniques reduce the processing logic overhead in software by providing a mathematically deterministic approach. Further, the techniques allow for communication bandwidth to be computed easily based on available slots. In case of addition of a new packet, the Table could be easily re-aligned without requiring any logic change in software, thereby reducing the testing time. The techniques can be tested mathematically and doesn't need physical testing to prove deterministic behavior. As a result, the techniques provide an efficient code in terms of timing margin.

[027] It is intended that the disclosure and examples be considered as exemplary only, with a true scope and spirit of disclosed embodiments being indicated by the following claims.

We claim:

1. A method of scheduling transmission for a plurality of communication packets, the method comprising:

receiving a plurality of communication packets having a plurality of associated cycle times;

5 determining a common time width for transmitting the plurality of communication packets based on the plurality of associated cycle times; and

distributing the plurality of communication packets in a Table comprising a plurality of slots, wherein each communication packet of the plurality communication packets is allocated a unique slot in the Table, and each slot accommodates a single communication packet of the
10 plurality communication packets.

2. The method as claimed in claim 1, wherein, the common time width is based on a highest common factor of the plurality of associated cycle times.

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Dated this 31st day of March 2020

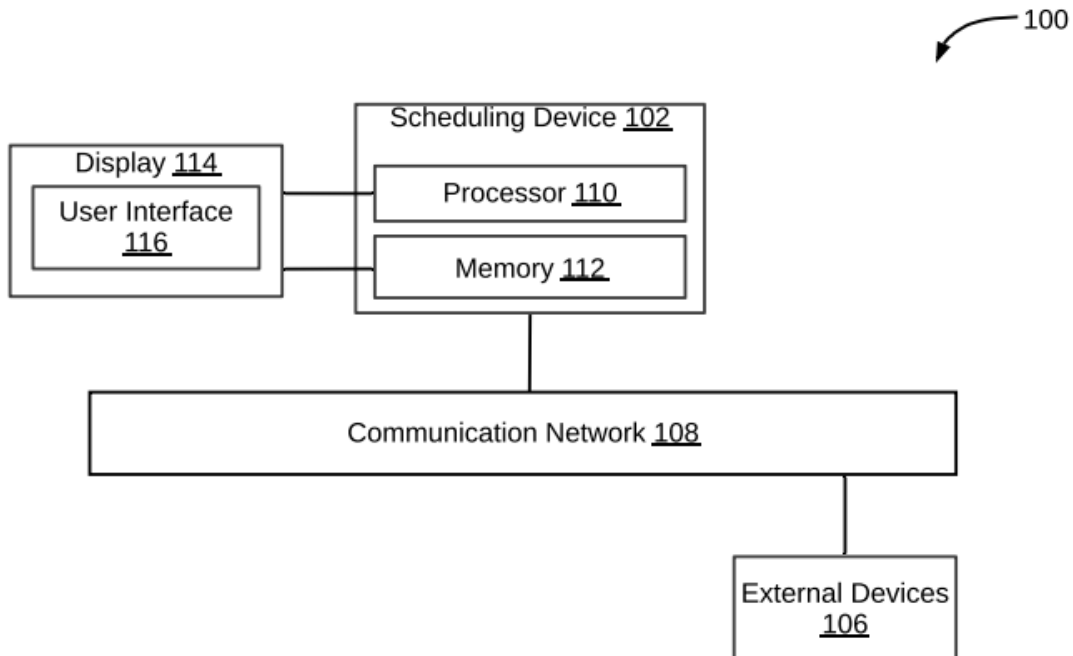
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A METHOD TO DETERMINISTICALLY TRANSMIT DATA FROM POINT TO POINT

ABSTRACT

A method of scheduling transmission for a plurality of communication packets is disclosed. The method may include receiving a plurality of communication packets having a plurality of associated cycle times. The method may further include determining a common time width for transmitting the plurality of communication packets based on the plurality of associated cycle times. The method may further include distributing the plurality of communication packets in a Table including a plurality of slots. Each communication packet of the plurality communication packets may be allocated a unique slot in the Table, and each slot may accommodate a single communication packet of the plurality communication packets



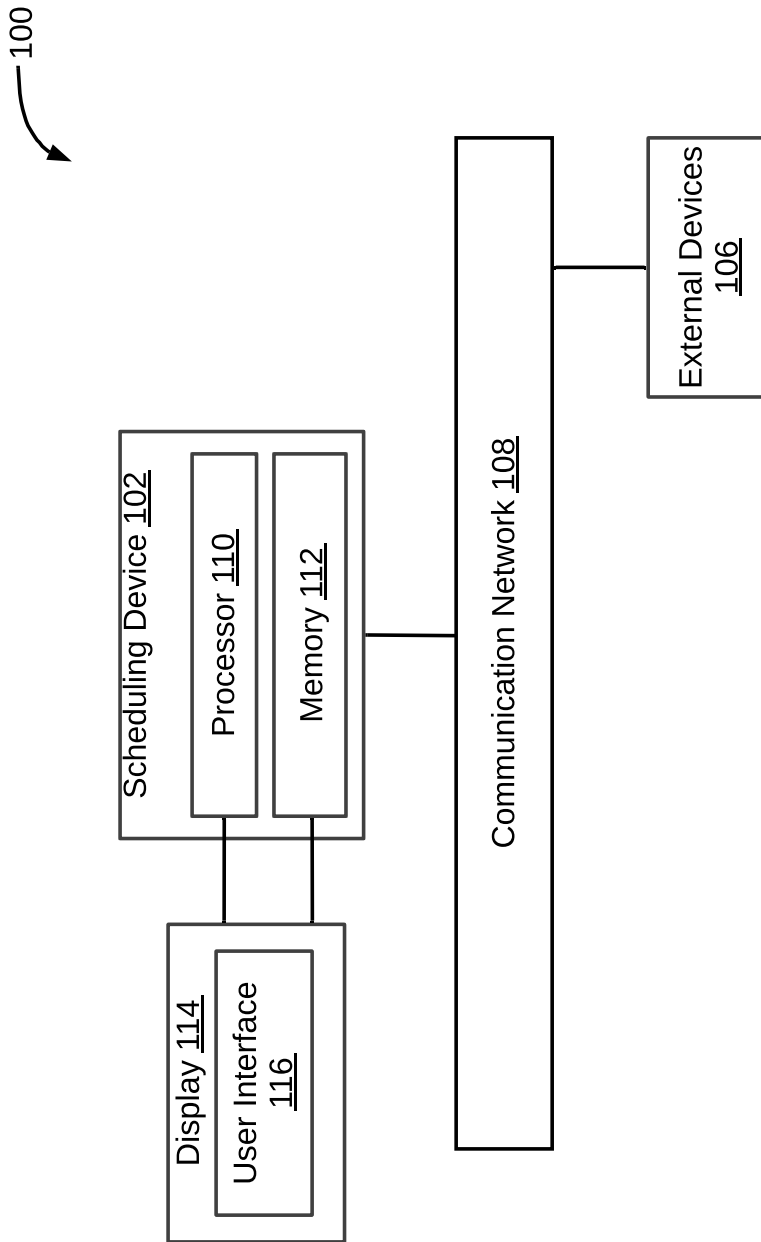


FIG. 1

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Table 200

Cycle	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20
ms	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
R1	P(100,1)	P(50,1)	P(20,1)	P(50,2)	P(100,2)	P(50,3)	P(20,1)	P(50,4)	P(100,3)	P(100,4)	P(20,1)	P(50,1)	P(200,1)	P(50,2)	P(20,1)	P(50,3)	P(200,2)	P(50,4)	P(20,1)	P(200,3)
R2	P(100,1)	P(50,1)	P(20,1)	P(50,2)	P(100,2)	P(50,3)	P(20,1)	P(50,4)	P(100,3)	P(100,4)	P(20,1)	P(50,1)	P(400,1)	P(50,2)	P(20,1)	P(50,3)	P(400,2)	P(50,4)	P(20,1)	P(400,3)
R3	P(100,1)	P(50,1)	P(20,1)	P(50,2)	P(100,2)	P(50,3)	P(20,1)	P(50,4)	P(100,3)	P(100,4)	P(20,1)	P(50,1)	P(200,1)	P(50,2)	P(20,1)	P(50,3)	P(200,2)	P(50,4)	P(20,1)	P(200,3)
R4	P(100,1)	P(50,1)	P(20,1)	P(50,2)	P(100,2)	P(50,3)	P(20,1)	P(50,4)	P(100,3)	P(100,4)	P(20,1)	P(50,1)	P(800,1)	P(50,2)	P(20,1)	P(50,3)	P(800,2)	P(50,4)	P(20,1)	P(800,3)
R5	P(100,1)	P(50,1)	P(20,1)	P(50,2)	P(100,2)	P(50,3)	P(20,1)	P(50,4)	P(100,3)	P(100,4)	P(20,1)	P(50,1)	P(200,1)	P(50,2)	P(20,1)	P(50,3)	P(200,2)	P(50,4)	P(20,1)	P(200,3)
R6	P(100,1)	P(50,1)	P(20,1)	P(50,2)	P(100,2)	P(50,3)	P(20,1)	P(50,4)	P(100,3)	P(100,4)	P(20,1)	P(50,1)	P(400,1)	P(50,2)	P(20,1)	P(50,3)	P(400,2)	P(50,4)	P(20,1)	P(400,3)
R7	P(100,1)	P(50,1)	P(20,1)	P(50,2)	P(100,2)	P(50,3)	P(20,1)	P(50,4)	P(100,3)	P(100,4)	P(20,1)	P(50,1)	P(200,1)	P(50,2)	P(20,1)	P(50,3)	P(200,2)	P(50,4)	P(20,1)	P(200,3)
R8	P(100,1)	P(50,1)	P(20,1)	P(50,2)	P(100,2)	P(50,3)	P(20,1)	P(50,4)	P(100,3)	P(100,4)	P(20,1)	P(50,1)	P(800,1)	P(50,2)	P(20,1)	P(50,3)	P(800,2)	P(50,4)	P(20,1)	P(800,3)
R9	P(100,1)	P(50,1)	P(20,1)	P(50,2)	P(100,2)	P(50,3)	P(20,1)	P(50,4)	P(100,3)	P(100,4)	P(20,1)	P(50,1)	P(200,1)	P(50,2)	P(20,1)	P(50,3)	P(200,2)	P(50,4)	P(20,1)	P(200,3)
R10	P(100,1)	P(50,1)	P(20,1)	P(50,2)	P(100,2)	P(50,3)	P(20,1)	P(50,4)	P(100,3)	P(100,4)	P(20,1)	P(50,1)	P(400,1)	P(50,2)	P(20,1)	P(50,3)	P(400,2)	P(50,4)	P(20,1)	P(400,3)
R11	P(100,1)	P(50,1)	P(20,1)	P(50,2)	P(100,2)	P(50,3)	P(20,1)	P(50,4)	P(100,3)	P(100,4)	P(20,1)	P(50,1)	P(200,1)	P(50,2)	P(20,1)	P(50,3)	P(200,2)	P(50,4)	P(20,1)	P(200,3)

FIG. 2

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Table 300

Cycle	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
ms	1	2	3	4	5	6	7	8	9	10
R1	P(5,1)	P(10,1)	P(15,1)	P(30,1)	P(20,1)	P(5,1)	P(10,2)	P(15,2)	P(10,3)	P(50,1)
R2	P(5,1)	P(10,1)	P(60,1)	P(30,2)	P(20,2)	P(5,1)	P(10,2)	P(15,1)	P(10,3)	P(100,1)
R3	P(5,1)	P(10,1)	P(15,2)	P(30,3)	P(20,1)	P(5,1)	P(10,2)	P(60,3)	P(10,3)	P(50,2)
R4	P(5,1)	P(10,1)	P(15,1)	P(30,1)	P(20,2)	P(5,1)	P(10,2)	P(15,2)	P(10,3)	P(100,2)
R5	P(5,1)	P(10,1)	P(60,2)	P(30,2)	P(20,1)	P(5,1)	P(10,2)	P(15,1)	P(10,3)	P(50,3)
R6	P(5,1)	P(10,1)	P(15,2)	P(30,3)	P(20,2)	P(5,1)	P(10,2)	P(60,4)	P(10,3)	P(50,1)
R7	P(5,1)	P(10,1)	P(15,1)	P(30,1)	P(20,1)	P(5,1)	P(10,2)	P(15,2)	P(10,3)	P(100,3)
R8	P(5,1)	P(10,1)	P(60,1)	P(30,2)	P(20,2)	P(5,1)	P(10,2)	P(15,1)	P(10,3)	P(50,2)
R9	P(5,1)	P(10,1)	P(15,2)	P(30,3)	P(20,1)	P(5,1)	P(10,2)	P(60,3)	P(10,3)	
R10	P(5,1)	P(10,1)	P(15,1)	P(30,1)	P(20,2)	P(5,1)	P(10,2)	P(15,2)	P(10,3)	P(50,3)
R11	P(5,1)	P(10,1)	P(60,2)	P(30,2)	P(20,1)	P(5,1)	P(10,2)	P(15,1)	P(10,3)	P(50,1)
R12	P(5,1)	P(10,1)	P(15,2)	P(30,3)	P(20,2)	P(5,1)	P(10,2)	P(60,4)	P(10,3)	P(100,1)
R13	P(5,1)	P(10,1)	P(15,1)	P(30,1)	P(20,1)	P(5,1)	P(10,2)	P(15,2)	P(10,3)	P(50,2)
R14	P(5,1)	P(10,1)	P(60,1)	P(30,2)	P(20,2)	P(5,1)	P(10,2)	P(15,1)	P(10,3)	P(100,2)
R15	P(5,1)	P(10,1)	P(15,2)	P(30,3)	P(20,1)	P(5,1)	P(10,2)	P(60,3)	P(10,3)	P(50,3)

FIG. 3

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