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**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY
(PCT Rule 43bis.1)**

To:

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FOR FURTHER ACTION
See paragraph 2 below

International application No.
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INV. H04L12/701 H04L12/803 H04L12/825 H04L12/947 H04L12/46 H04L12/717

Applicant
FUNGIBLE, INC.

1. This opinion contains indications relating to the following items:

- Box No. I Basis of the opinion
- Box No. II Priority
- Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- Box No. IV Lack of unity of invention
- Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- Box No. VI Certain documents cited
- Box No. VII Certain defects in the international application
- Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA:



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Date of completion of
this opinion

see form
PCT/ISA/210

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Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:
 - the international application in the language in which it was filed.
 - a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).
2. This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))
3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:
 - a. forming part of the international application as filed:
 - in the form of an Annex C/ST.25 text file.
 - on paper or in the form of an image file.
 - b. furnished together with the international application under PCT Rule 13ter.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
 - c. furnished subsequent to the international filing date for the purposes of international search only:
 - in the form of an Annex C/ST.25 text file (Rule 13ter.1(a)).
 - on paper or in the form of an image file (Rule 13ter.1(b) and Administrative Instructions, Section 713).
4. In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
5. Additional comments:

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	<u>5-8, 12-29</u>
	No: Claims	<u>1-4, 9-11</u>
Inventive step (IS)	Yes: Claims	
	No: Claims	<u>1-29</u>
Industrial applicability (IA)	Yes: Claims	<u>1-29</u>
	No: Claims	

2. Citations and explanations

see separate sheet

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

1 **Re Item V**

1.1 Reference is made to the following documents:

D1 US 2010/061391 A1 (SINDHU PRADEEP [US] ET AL) 11 March 2010
(2010-03-11)

D2 US 2015/244617 A1 (NAKIL HARSHAD BHASKAR [US] ET AL) 27
August 2015 (2015-08-27)

1.2 **Independent Claims**

The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claim 1 is not new in the sense of Article 33(2) PCT and the subject-matter of claims 20 and 27 does not involve an inventive step within the sense of Article 33(3).

1.2.1 Claim 1

1.2.1.1 **D1** discloses (the references in parenthesis applying to this document):

A network system comprising:

a plurality of servers (**Figure 1**);

a switch fabric comprising a plurality of core switches (**paragraph 35, "The data center 100 includes a switch core (SC)"**); and

a plurality of access nodes, each of the access nodes coupled to a subset of the servers and coupled to a subset of the core switches, wherein the access nodes include a source access node and a destination access node each executing a fabric control protocol, FCP (**paragraph 39, "the switch core 180 includes an edge portion 185 and a switch fabric 187. The edge portion 185 can include edge devices (not shown) that can function as gateway devices between the switch fabric 187 and the peripheral processing devices 170"**, **Figure 1, "110"**, **paragraph 35, "The data center 100 includes a switch core (SC) 180 operably connected to four types of peripheral processing devices 170: compute nodes 110, service nodes 120, routers 130, and storage nodes 140"**, **paragraph 48, "the compute nodes 110 can be [...] servers"**, **paragraph 64, "when several (or all) of the peripheral processing devices 210 shown in FIG. 2 are attempting to access peripheral processing device PD at a given time"**, **paragraph 105, "The input/output modules 502 (which can be, for example, edge devices) are configured to send data to and/or receive data from the first switch fabric portion 571 and/or the second switch**

fabric portion 573. Additionally, each input/output module 502 can include a parsing function, a classifying function, a forwarding function, and/or a queuing and scheduling function", where edge devices are interpreted as the access nodes and they are in charge of forwarding to/from the switch fabric and servers; and where servers communicate with each other through the edge devices and fabric switch, thereby having source and destination servers and corresponding edge devices),

wherein the source access node is configured to send an FCP request message for an amount of data to be transferred in a packet flow from a source server coupled to the source access node to a destination server coupled to the destination access node (**Figure 19, paragraph 168, "the ingress schedule module 1620 can be configured to send a request to schedule the group of cells GA for transmission via the switch fabric 1600 [...] the transmission request 22 can include a request to transmit the group of cells GA via a particular transmission path (such as transmission path 4112 shown in FIG. 16A) through the switch fabric 1600, or at a particular time", paragraph 173, "the transmission request 22 includes a cell quantity value 30", where a request to send a number of cells (amount of data) through a path is sent to the egress module), and**

in response to receipt of an FCP grant message indicating an amount of bandwidth reserved for the packet flow (**Figure 19, paragraph 171, "If the egress schedule module 1630 determines that the destination port of the group of cells GA (i.e., egress port P1 shown in FIG. 16A) is available to receive the group of cells GA, the egress schedule module 1630 can be configured to send a transmission response 24 to the ingress schedule module 1620 [...] authorization for the group of cells GA to be transmitted can be granted when transmission across the switch fabric 1600 is substantially guaranteed", Figure 16B, paragraph 181, "The queue identifier 34 and the queue sequence value 36 can be included in the transmission response 24", paragraph 283, "a queue ID can be associated with a flow rate parameter value. The flow rate parameter value can indicate a flow rate (e.g., a maximum flow rate) at which transmit queues (represented by the queue IDs) should transmit data", where the response grant/authorisation message includes a queue ID which indicates a flow rate/bandwidth at which queues should**

transmit data thereby indicating an amount of bandwidth reserved for the packet flow), spray FCP packets of the packet flow across a plurality of parallel data paths in accordance with the reserved bandwidth (**Figure 16A, paragraph 40, "data packets can be parsed into cells at the edge device of edge portion 185, and the cells can be transmitted from the edge device to the switch fabric 187", paragraph 167, "the cells 4110 can include content (e.g., data packets) received at the switch core 1690 from one or more peripheral processing devices", paragraph 166, "As shown in FIG. 16A, the group of cells GA can be transmitted via a transmission path 4112 that is different than a transmission path 4114 through which the group of cells GC is transmitted", where cells of a packet flow are transmitted/sprayed through different paths towards a destination**), and

wherein the destination access node is configured to, in response to receipt of the FCP request message, perform grant scheduling and send the FCP grant message indicating the amount of bandwidth reserved for the packet flow (**see above**), and in response to receiving the FCP packets of the packet flow, deliver the data transferred in the packet flow to the destination server (**paragraph 39, "edge devices within the edge portion 185 can collectively have thousands of ports [...] through which data from the peripheral processing devices 170 can be transmitted (e.g., routed) into and/or out of one or more portions of the switch core 180", where destination edge devices transmit data to destination servers/peripherals**).

1.2.1.2 Therefore, the present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claim 1 is not new in the sense of Article 33(2) PCT.

1.2.2 Claim 20

1.2.2.1 **D2** is considered to be the prior art closest to the subject-matter of claim 20 and discloses (the references in parenthesis applying to this document; the crossed text applying to missing features):

A method (**Abstract**) comprising:

establishing a logical tunnel over a plurality of parallel data paths between a source access node and a destination access node within a computer network, wherein the source and destination access nodes are respectively coupled to one or more servers, wherein the source and destination access nodes are connected by an intermediate network comprising a switch fabric

having a plurality of core switches, and wherein the source and destination access nodes are each executing a fabric control protocol, FCP (**Figure 2B, paragraph 95, "encapsulation and de-capsulation functions may be performed at the edge of switch fabric 14 at a first-hop TOR switch 16 that is one hop removed from the application instance that originated the packet. This functionality is referred to herein as tunneling and may be used within data center 10 to create one or more overlay networks", paragraph 97, "virtual machine 36 VM1 sends a packet 41, an "inner packet," virtual switch 30A by an internal link. Virtual switch 30A uses NFT1 to look up a virtual network destination network address for packet 41. NFT1 specifies an outbound interface for virtual switch 30A and encapsulation for packet 41. Virtual switch 30A applies the encapsulation to add a tunnel header to generate outer packet 43 and outputs outer packet 43 on the outbound interface, in this case toward TOR switch 16A", paragraph 127, "The different tunnel encapsulation headers allow multiple equal cost paths in the physical network to be used", paragraph 10, "The tunnel header allows the physical network to tunnel the inner packet toward a destination virtual switch for delivery to a destination application instance", paragraph 12, "A tunnel termination virtual network element, or "tunnel endpoint," ordinarily decapsulates received outer packets of the tunneled packet flow to remove the outer header and forwards the resulting inner packet toward an application.", where tunnels are established between edge nodes of a switch fabric to transfer data through the switch fabric to/from source and destination servers and where multiple paths may be used to transfer tunneled data packets);**

~~sending, by the source access node, an FCP request message for an amount of data to be transferred in a packet flow from a source server coupled to the source access node to a destination server coupled to the destination access node; and~~

~~in response to receipt of an FCP grant message indicating an amount of bandwidth reserved for the packet flow, forwarding FCP packets of the packet flow by spraying, by the source access node, the FCP packets across the plurality of parallel data paths~~ (**paragraph 127, "The different tunnel encapsulation headers allow multiple equal cost paths in the physical network to be used", paragraph 182, "the tunnel endpoint may allocate a packet flow to any one of a plurality of equal-cost multipaths to reach a**

packet flow destination", where multiple paths between the source and destination endpoints may be used) ~~in accordance with the reserved bandwidth.~~

1.2.2.2 The subject-matter of claim 20 differs from D2, as underlined, in that:

sending, by the source access node, an FCP request message for an amount of data to be transferred in a packet flow from a source server coupled to the source access node to a destination server coupled to the destination access node; and
in response to receipt of an FCP grant message indicating an amount of bandwidth reserved for the packet flow [...] in accordance with the reserved bandwidth

1.2.2.3 The technical effect of the underlined differentiating features is that transfers are performed as granted by the destination.

1.2.2.4 The objective technical problem to be solved may be therefore regarded as improving the method of D2 so that data transfers are regulated.

1.2.2.5 The skilled person departing from D2 and aiming to solve the above mentioned problem, would investigate possible alternatives to regulate data transfers over a switch fabric. Looking into this common problem and possible solutions, the skilled person would see in D1, an alternative to regulate data transfers over a switch fabric (**D1, Figure 19, paragraph 168, "the ingress schedule module 1620 can be configured to send a request to schedule the group of cells GA for transmission via the switch fabric 1600 [...] the transmission request 22 can include a request to transmit the group of cells GA via a particular transmission path (such as transmission path 4112 shown in FIG. 16A) through the switch fabric 1600, or at a particular time", paragraph 173, "the transmission request 22 includes a cell quantity value 30", paragraph 171, "If the egress schedule module 1630 determines that the destination port of the group of cells GA (i.e., egress port P1 shown in FIG. 16A) is available to receive the group of cells GA, the egress schedule module 1630 can be configured to send a transmission response 24 to the ingress schedule module 1620 [...] authorization for the group of cells GA to be transmitted can be granted when transmission across the switch fabric 1600 is substantially guaranteed", Figure 16B, paragraph 181, "The queue identifier 34 and the queue sequence value 36 can be included in the transmission response 24", paragraph 283, "a queue ID can be associated with a flow**

rate parameter value. The flow rate parameter value can indicate a flow rate (e.g., a maximum flow rate) at which transmit queues (represented by the queue IDs) should transmit data", where requests for transferring data and corresponding responses are exchanged among ingress and egress nodes of the fabric to regulate transfers and where the response grant/authorisation message includes a queue ID which indicates a flow rate/bandwidth at which queues should transmit data). Hence, it would be obvious to the skilled person to use the teachings of D1 (as per above) to request and grant data transfers over the switch fabric. Thereby arriving to a method according to claim 20 without exercising inventive skill.

1.2.2.6 Therefore, the present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claim 20 does not involve an inventive step within the meaning of Article 33(3) PCT.

1.2.3 Claim 27

The objections provided above for claim 20 apply, *mutatis mutandis*, to the subject-matter of corresponding independent claim 27 (Article 33(3) PCT).

1.3 **Dependent claims**

The dependent claims do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step.

1.3.1 Dependent claims 2, 3, 25, 26

D1 discloses the features of these claims (**Figure 13**).

1.3.2 Dependent claims 4, 22

The features of these claims are implicit from D1 as the queue id limits the rate of transfer.

1.3.3 Dependent claims 5, 6, 7, 8, 18, 23, 24

The features of this claim represent obvious options that the person skilled-in-the-art would implement to transfer cells over the different available paths. See also D2 (**paragraph 303, "ECMP paths between first and second network devices such as servers 2252 may be viewed by the virtual network as one physical connection, as their packet (inner packet) is encapsulated by the outer IP encapsulation"**).

1.3.4 Dependent claim 9, 10, 11, 28, 29

D1 discloses the features of these claims (**paragraph 40, "data packets can be parsed into cells at the edge device of edge portion 185, and the cells can be transmitted from the edge device to the switch fabric 187. The cells can be parsed into segments and transmitted within the switch fabric 187 as segments (also can be referred to as flits in some embodiments)", paragraph 155, " After the segments of the cells have been processed through the shared memory buffer, the segments of the cells can be ordered and sent from the buffer module 1500 during a reassembly process", see also paragraphs 201-202)**)

1.3.5 Dependent claims 12, 13, 14, 19

The features of these claims represent obvious options that the person skilled-in-the-art would implement to further regulate the transmission of cells (**see paragraphs 252-253, "the flow control signal can define a request to transmit data from one or more of the transmit queues 2336 at a specified rate (e.g., specified number of frames per second, specified number of bytes per second) [...] a flow control signal (e.g., the suspension time period within the flow control signal) can be defined [...] based on a time period during which a receive queue from the receive queues 2346 (e.g., first-stage receive queue QD4) will be unavailable."**).

1.3.6 Dependent claims 15, 16, 17

The features of these claims represent straight-forward implementation options that the person skilled in the art would adopt for delivering traffic over the network without involving an inventive skill.

1.3.7 Dependent claim 21

The features of this claim are obvious from D1 (**paragraph 40, "data packets can be parsed into cells at the edge device of edge portion 185, and the cells can be transmitted from the edge device to the switch fabric 187. The cells can be parsed into segments and transmitted within the switch fabric 187 as segments (also can be referred to as flits in some embodiments)", paragraph 155, " After the segments of the cells have been processed through the shared memory buffer, the segments of the cells can be ordered and sent from the buffer module 1500 during a reassembly process", see also paragraphs 201-202).**)

2 Item VII

2.1 Independent claims 1, 20 and 27 are not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features known in combination from the prior art being placed in the preamble (Rule 6.3(b)(i) PCT) and the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).

2.2 The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

2.3 Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in D1-D2 is not mentioned in the description, nor are these documents identified therein.

3 Item VIII

3.1 Given that claims 20 and 27 are both in the method category and comprise corresponding features, the claims do not meet the requirement of conciseness, Art. 6 PCT.

3.2 The acronyms placed between brackets ("FCP", "UDP", "ECMP") are presented as reference signs, thereby rendering the related claims unclear (Article 6 PCT). It is suggested to replace brackets by commas as in ", FCP,".

3.3 The claims refer to a Fabric Control Protocol, FCP. However, such protocol is not a protocol known in the state of the art. Since no particular features are defined to differentiate such protocol, the references to such protocol are interpreted as a generic protocol.