

Western Digital Technologies, Inc.
v.
Shamrock Innovations, Inc.

Petitioner's Demonstrative Exhibits

July 17, 2024

Case No. IPR2023-00842

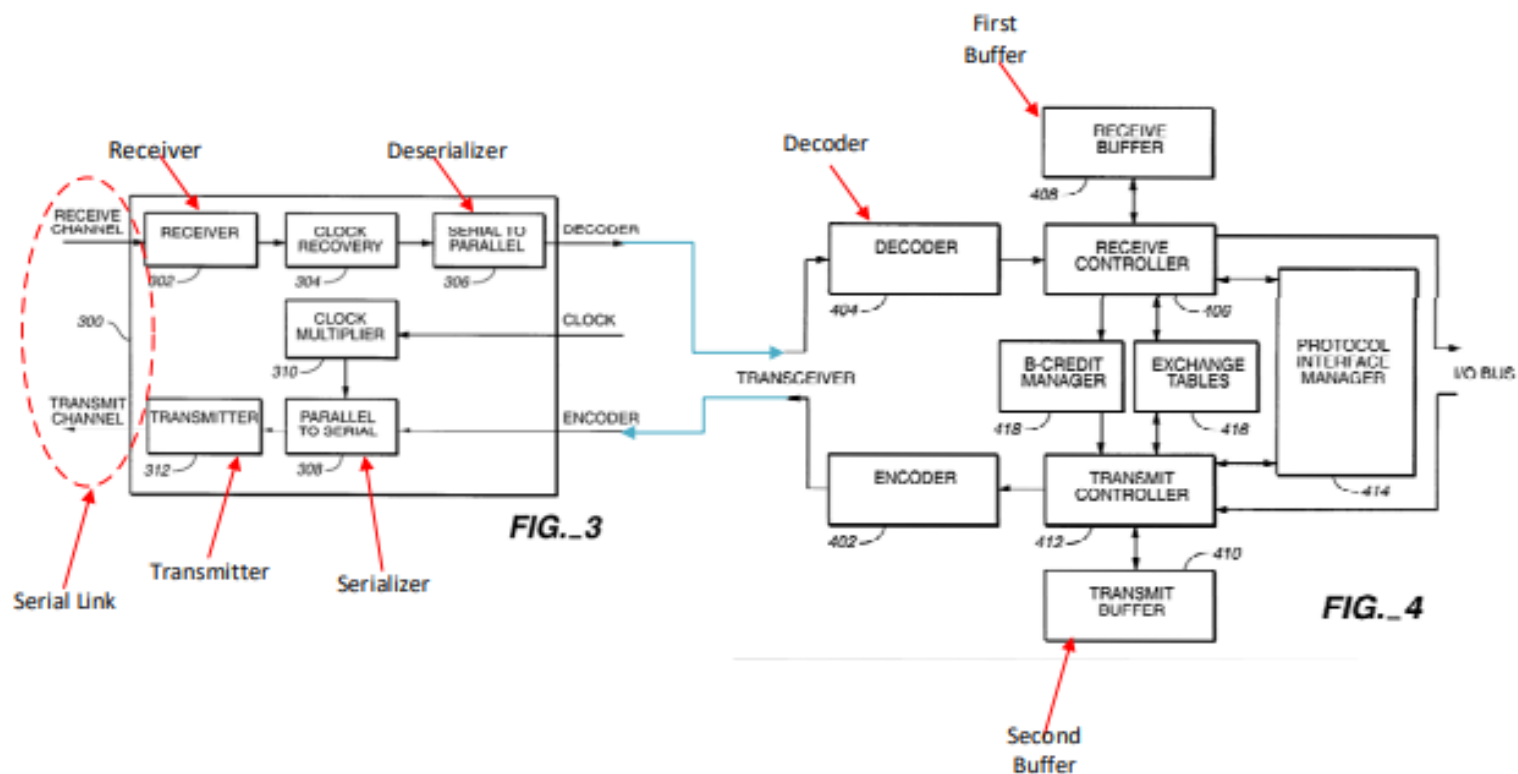
United States Patent and Trademark Office, Patent Trial and Appeal Board

Vangemert/Copeland – Flow Control Transmission

Summary of Vangemert

- Vangemert is directed to an improved buffer-credit based system for use in high-speed serial communications, particularly within a Fibre Channel system. Pet. At 6; *see also*, Reply at 17; EX. 1005 at 1:8-10.
- Fibre Channel requires an initiating node to receive a buffer-credit from a responding node indicating that space is available in the receive buffer for a data frame. POR at 20; *see also*, EX. 1005 at 4:8-11.

Summary of Vangemert



Vangemert Modified Combined FIGs. 3 and 4 (Annotated)

Summary of Vangemert

- The buffer-credit system of Vangemert is used to reduce latencies within the Fibre Channel system.
- For example, the improved buffer-credit calculations of Vangemert are used where “minimum latencies are required.” Pet. at 31; *see also*, EX. 1005, at 1:54-63.
- Vangemert teaches a “network interface unit which implements a low latency algorithm for buffer credit calculation.” Pet. At 6; *see also*, Reply at 9, EX. 1005, at 1:66-2:1.

Disputed Limitation - Flow Control Transmission in Vangemert

Relevant Excerpt of Claim 1

- [W]herein the module is further configured to transmit the flow control signal through the serial link and the connector without passing the flow control signal through the second buffer.

Flow Control Transmission– Vangemert Teaches

Vangemert expressly teaches transmitting a flow control signal “through the serial link and the connector without passing the flow Control signal through the second buffer.” Pet. At 30-31; see also, Reply at 3.

- The buffer credit manager 418 is configured to generate a bit credit signal “when it determines that the additional committed buffer space (i.e. the buffer space committed but not yet occupied) is less than the available buffer capacity by at least the size of one data frame.” Pet. at 30-31; see also, Reply at 8, 10, EX. 1005 at 4:25-29.
- “[W]hen receive controller 406 receives a control word indicating [] a remote node wishes to transmit data, the buffer credit manager 418 is enabled, and the transmit controller 412 **begins transmitting buffer credit control words** in response to a credit signal from the buffer credit manager 418.” Pet. at 30-31; see also, Reply at 8, 10; EX. 1005 at 4:11-16 (emphasis added).

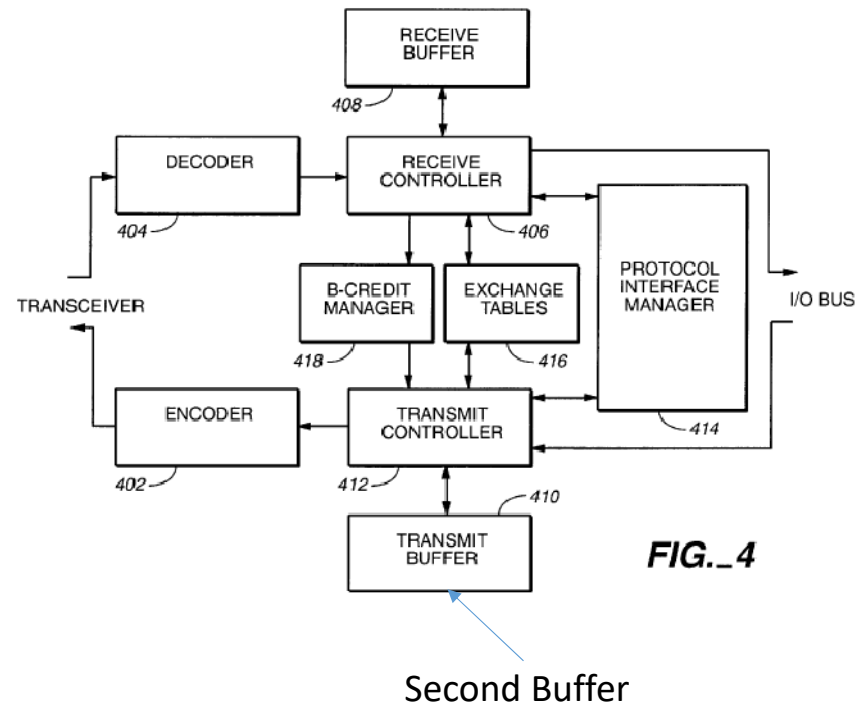


FIG. 4

Flow Control Transmission– Caloyannides Opinion – BCCW Not Passed Through Transmit Buffer

Dr. Caloyannides testified that a PHOSITA would understand that the buffer credit control word of Vangemert is not passed through the transmit buffer. Pet. at 30-31.

Dr. Caloyannides testified that Vangemert provides a fast, low latency Fibre Channel system by sending the buffer credit control word directly to the encoder from the transmit controller without passing through the transmit buffer 410. See Pet. at 31, *see also*, EX. 1003 at ¶ 77.

78. Accordingly, putting the credit signal in the buffer would make no sense to one of skill because the credit signal is not part of a data frame or packet to be sent but is rather a control signal that must be sent in response to a request to transmit data by a remote device. In fact, this would be an inefficient method of operation, and would therefore be opposite to a goal of Vangemert which is to reduce data transmission latency for high-speed data connections. See EX. 1005, at col. 1:54-55.

79. Accordingly, a PHOSITA would have understood to transmit the control signal, bypassing the transmit buffer, as the command did not need to be packaged with other data, but needed to be transmitted quickly in response to the request by the remote device to transmit data to minimize transmission latency for high-speed data connections.

Flow Control Transmission– Caloyannides Opinion

Mr. Lee agrees with Dr. Caloyannides, stating that the buffer credit system of Vangemert ensures “efficient and timely flow control in the network.” *See*, EX. 2002 at ¶ 55.

Mr. Lee said that buffer credits “are a vital flow control mechanism in high-speed networks like Fibre Channel, designed to manage data transfer efficiently and prevent loss,” and notes that the dynamic exchange “allows the sender to adjust its data transmission rate **in real-time**, aligning with the receiver’s capacity to process the incoming data.” *See*, EX. 2002 at ¶¶ 78-79 (Emphasis added).

Flow Control Transmission– Grimsrud Opinion

Dr. Grimsrud's un rebutted testimony stated that to provide a fast, low latency system within a Fibre Channel device, the buffer credit control word would be sent "directly to the encoder 402 without adding the step of passing it through the transmit buffer." Reply at 9; *see also*, EX. 1013 at ¶22.

Dr. Grimsrud further testified that storing the buffer credit control word in the transmit buffer would be illogical and "adverse to sound engineering practices," as "passing the BCCW [Bit Credit Control Word] through the transmit buffer [as hypothesized by Mr. Lee] would add unnecessary steps and increase latency over a system in which the 'transmit controller 412 *begins* transmitting buffer credit control words in response to a credit signal from the credit manager 418.'" Reply at 9; *see also*, EX. 1013 at ¶24 (citing EX. 1005 at 4:14-16)(emphasis in original).

Flow Control Transmission– Grimsrud Opinion

Dr. Grimsrud testified Mr. Lee's unsupported hypothesis violates sound engineering practices as understood by a PHOSITA. *See*, EX. 1013 at ¶ 24.

- Dr. Grimsrud testified that storing the buffer credit control word in the transmit buffer, as proposed by P.O.'s expert Mr. Lee, prior to transmitting would “increase latency by introducing unnecessary steps and creating unbounded transmission protocol” resulting in increases to latency. This increase in latency again is in opposition to Vangemert's goal of providing a fast, low latency system. EX1013, ¶24; *see also* Reply at 10.
- As detailed by Dr. Grimsrud, unbounded communication is the result of requiring flow control signals to be stored in a FIFO buffer, resulting in unknown times for a flow control signal to pass through the FIFO buffer, as the transmission would depend on the amount of data in the data, as well as the size of the buffer. EX. 1013 at ¶ 28; *See also*, Reply at 11.
- Dr. Grimsrud testified that creating such an unbounded system is unsound engineering practice that results in validation challenges as well as delays in delivery of the buffer credit control word. Reply at 11; *see also*, EX. 1013 at ¶ 24.

Flow Control Transmission– Grimsrud Opinion

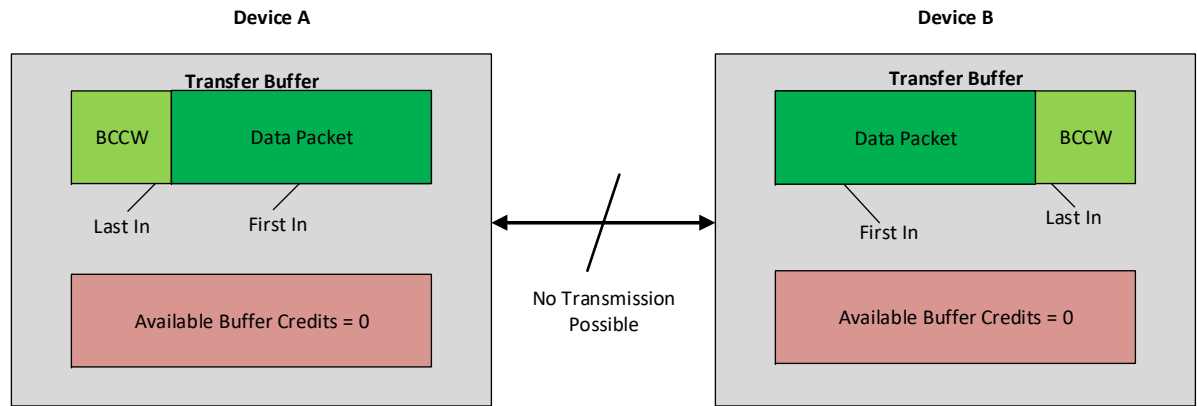
Dr. Grimsrud further testified that adopting PO's position that the buffer credit control word would be stored in the transmit buffer could lead to an undesirable deadlock condition within the system. EX. 1013, ¶¶ 26, 29-30; *see also*, Reply at 11-12.

- A deadlock condition occurs where flow control signals in both receiving and transmit devices are stored in a buffer, but no data can pass between the devices as both devices are awaiting a flow control signal (i.e. a buffer credit). Thus, no data can be transmitted, resulting in an undesirable deadlock condition wherein neither node (i.e., two communicating devices) can transmit the required flow control signal to the other to facilitate data transfers. EX. 1013, ¶¶ 26, 29-30; *see also*, Reply at 11-12.

Flow Control Transmission– Grimsrud Opinion

29. The Fibre Channel protocol (and others such as Serial ATA) may experience a condition known as deadlock if the flow control signal is added to the tail of the transmit FIFO in the transfer buffer. The following scenario is a simple case that highlights this deadlock behavior if the flow control signal does not bypass the transmit buffer:

1. Side A is out of transfer credits (BCCWs) from Side B but has a frame of data already queued up in the transfer buffer (which you would expect if it has been waiting to get a flow control credit).
2. Side B is completing a transfer to Side A that exhausts Side B's transfer credits (BCCWs). Side B also has a subsequent pending frame to transmit in its transfer buffer after the current one finishes (which is expected since efficient implementations will strive to have the next frame ready to go as soon as previous one is done).
3. If Side A inserts its flow control signal granting Side B a credit into the transfer buffer (which has a frame of data already pending), then that signal will not be transmitted because it is stuck behind the data frame which cannot be transmitted due to lack of transfer credits on Side B, preventing further transmission by Side A.
4. Similarly, Side B cannot send Side A a credit to allow it to empty the data frame that is stuck ahead of the flow control credit because it is also unable to transmit the data frame that is ahead of its flow control signal.



(Source: EX1013, ¶¶ 26, 29-30; Pet. Reply. at 11-12.)

Demonstrative Exhibit – Not Evidence – 13

Flow Control Transmission– Grimsrud Opinion –

- To rebut Mr. Lee, Dr. Grimsrud relies on his expertise in serial communication, and supports his testimony using “Tachyon: A Gigabit Fibre Channel Protocol Chip” (“The Tachyon Article”). The Tachyon Article (EX. 1014), which is a complementary article to EX. 2012 provided by PO. *See*, Reply at 12,16; *see also*, EX1013 at ¶¶ 33, 37.

Flow Control Transmission– Grimsrud Opinion –

The Tachyon Article illustrates a Fibre Channel system (and follows, as well as shares an author with, the EX. 2012 article), entitled “An Introduction to Fibre Channel.”* See EX. 1014.

- EX. 2012 states “the Tachyon Fibre Channel protocol described in Article 12 implements the FC01 and FC02 layers.” Article 12 is understood to reference the Tachyon Article. Reply at 12-13; *see also*, EX. 2012 at 5. The Tachyon Article, as asserted by Dr. Grimsrud, confirms the teaching of Vangemert that the Buffer Credit Control Word does not pass through the transmit buffer. Reply at 13.

* Dr. Grimsrud misspoke in stating that “Patent Owner and Mr. Lee relied on the Tachyon Article.” Rather, Dr. Grimsrud intended to restate that it was understood that Patent Owner and Mr. Lee relied on EX. 2012, which cross-references the Tachyon Article and shares a common author therewith. See, EX. 1003 at 33; *see also*, EX. 2012 at p. 5, EX. 1014 at 96.

Flow Control Transmission– Grimsrud Opinion – Tachyon Article

Dr. Grimsrud testified that the flow control signals referenced in the Tachyon Article are used to increment the end-to-end count that “determines the number of frames that Tachyon can send to the remote designation without receiving an ACK.” EX1013 at ¶¶ 34-35, *see also*, Reply at 13-15; EX. 1014 at p. 102.

The Tachyon Article describes that a “transmitter starts with the number of flow control credits initially set, and with each transmission it decrements (decreases by one) the credits it has to transmit further. When it reaches zero credits it may no longer transmit. For each ACK the transmitter receives back from the receiver, it increments (increases by one) the transmit credits it has available.” POR at . 13, EX1013 at ¶ 34.

Flow Control Transmission– Grimsrud Opinion – Tachyon Article

- The ACK signals therefore provide flow control signals managing the credits that a transmitting device has available, thereby making them analogous to the Buffer Credit Control Word of Vangemert. Reply at 13; *see also*, EX1013 at ¶ 34.

Flow Control Transmission– Grimsrud Opinion – Tachyon Article

As shown in Fig. 6 of The Tachyon Article (as well as Figs. 4 and 5), the ACK signals pass through an “ACK FIFO” (highlighted in green). EX1013 at ¶¶ 34-35, *see also*, Reply at 13-15.

As highlighted in yellow, the outbound data path (i.e., data frames) is output to the Outbound Frame FIFO (transmit buffer) along a separate path (and using a separate buffer) than the ACK signal. *Id.*

This bypassing of the Outbound Frame FIFO “[a]llows time-critical messages [such as the Buffer Credit Control Word of Vangemert] to bypass the normal traffic waiting for various resources via a low-latency, high priority path.” EX. 1013 at ¶ 36, *see also*, Reply at 13-14.

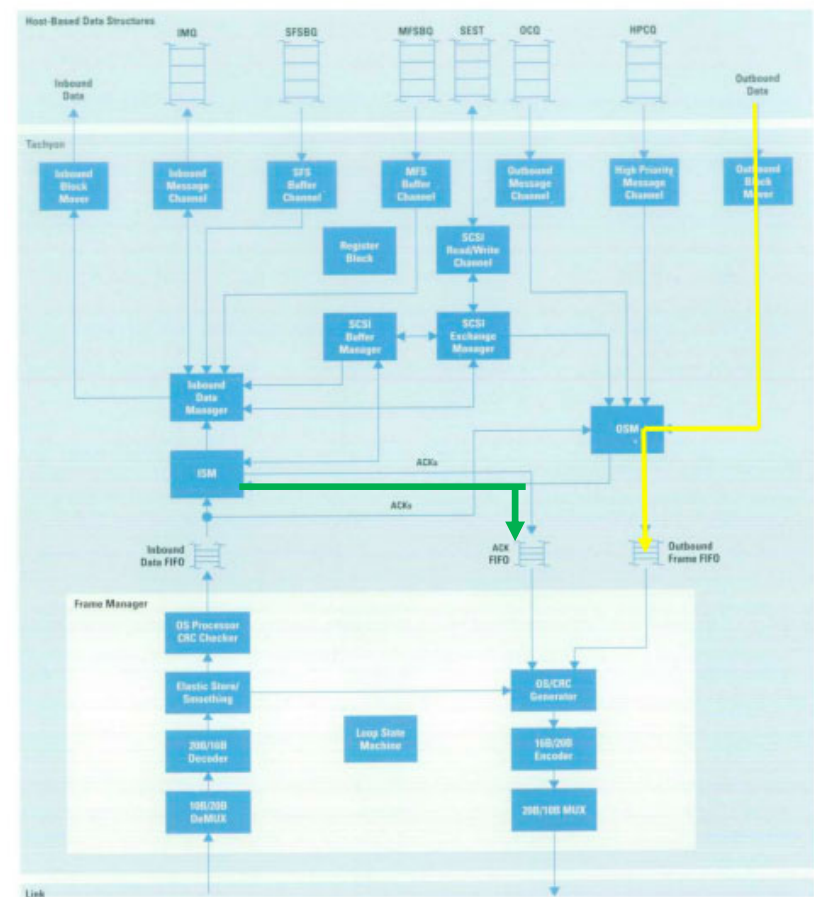


Exhibit 1014 Figure 6 (Annotated)

Vangemert/Copeland – Flow Control Generation

Flow Control Transmission- Claim

Relevant Claim Element – Flow Control Transmission

wherein the module is operable to generate a flow control signal in response to the amount of data stored in the first buffer equaling or exceeding the fill amount, and wherein the module is further configured to transmit the flow control signal through the serial link and the connector without passing the flow control signal through the second buffer.

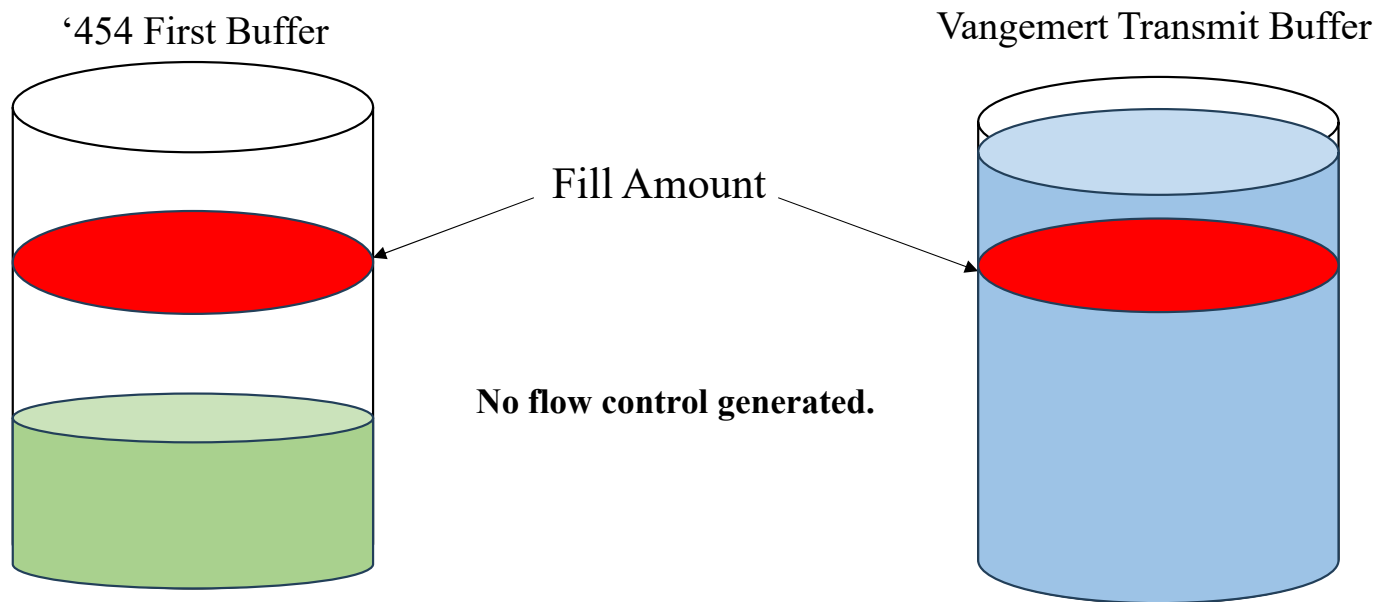
Flow Control Generation – Vangemert Teaches

Vangemert expressly recites generating “a flow control signal in response to the amount of data stored in the first buffer **equaling** or exceeding the fill amount.”

- First, the “fill amount” of Vangemert is equal to the available buffer capacity less committed buffer space as determined by the buffer credit manager 418. Pet. at 27-28; EX. 1003 at ¶¶ 67-69 EX1005, col. 4: 9-31.
- The buffer credit manager 418 generates a credit upon determining the committed buffer space (fill amount) is less than the available buffer capacity by at least the size of one data frame. The credit is then packaged into a Buffer Credit Control Word by the transmit controller 412. *Id.*
- This generation of the credit signal teaches generating “a flow control signal in response to the amount of data stored in the first buffer equaling . . . the fill amount.

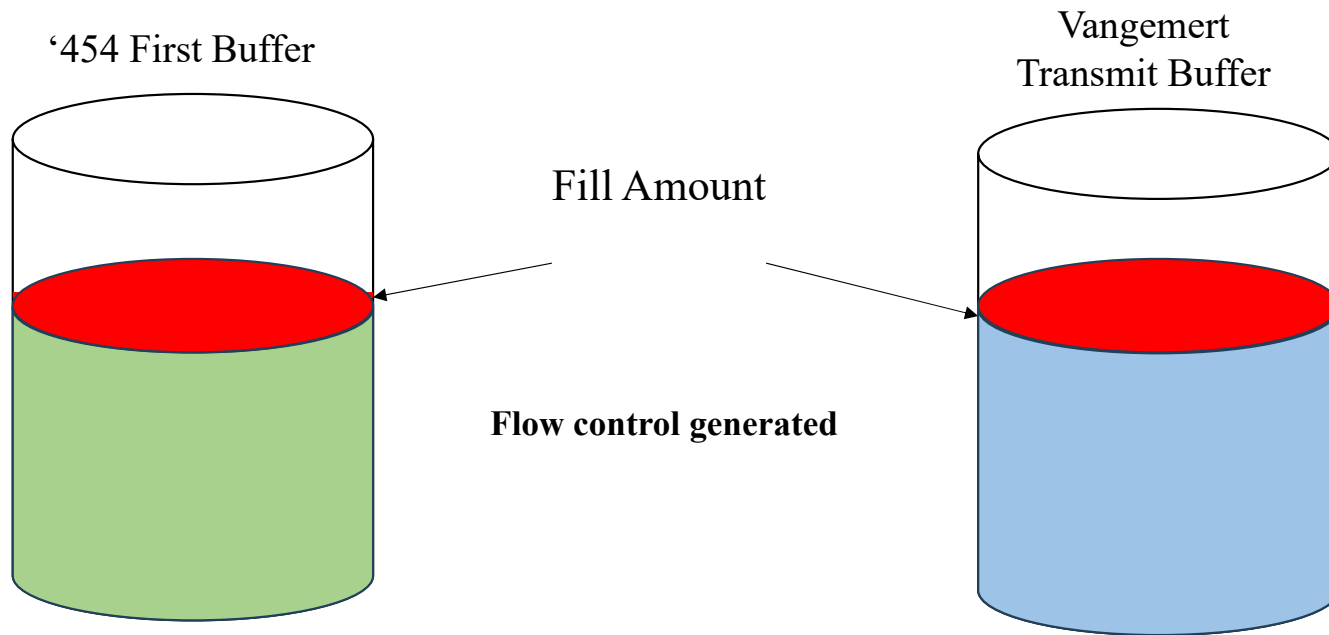
Flow Control Generation – Vangemert Teaches

As shown in the example below, when the data amount in the buffer of the '454 Patent is below the fill amount, and the data amount in the buffer of Vangemert is above the fill amount, no flow control signals are generated. See Pet. at 28.



Flow Control Generation – Vangemert Teaches

In response to the data amount in the receive buffer of the '454 Patent reaching the fill amount, a flow control signal is generated. Similarly, in response to the data amount in the receive buffer of Vangemert reaching the fill amount, a flow control signal is generated. *See* Pet. At 28.



Flow Control Generation – Vangemert Teaching

The generated buffer credit must be provided by an initiating (transmitting) node for the initiating node to transmit a data frame to a responding (receiving node), thus providing flow control within the system of Vangemert. EX1005, col. 4: 9-31, *see also* Pet. at 28.

- Mr. Lee admitted that the buffer credit system of Vangemert teaches “flow control to avoid buffer overflow.” EX. 2002 at ¶ 84.

Flow Control Signal Generation – Dr. Caloyannides Opinion

Dr. Caloyannides testified that Vangemert teaches generating the flow control signal (bit credit, later to be packaged into the Buffer Credit Control Word) in response to the available space in the buffer equaling the fill amount. Pet. at 28; *see also*, EX. 1003 at ¶¶ 68-69.

PO Waiver

PO Waiver

PO did not argue that Vangemert does not teach generating “a flow control signal in response to the amount of data stored in the first buffer equaling or exceeding the fill amount in either the PO Response or Mr. Lee’s declaration. *See generally*, POR.

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Combination of Vangemert and Copeland is Proper

The Combination of Vangemert and Copeland Is Proper

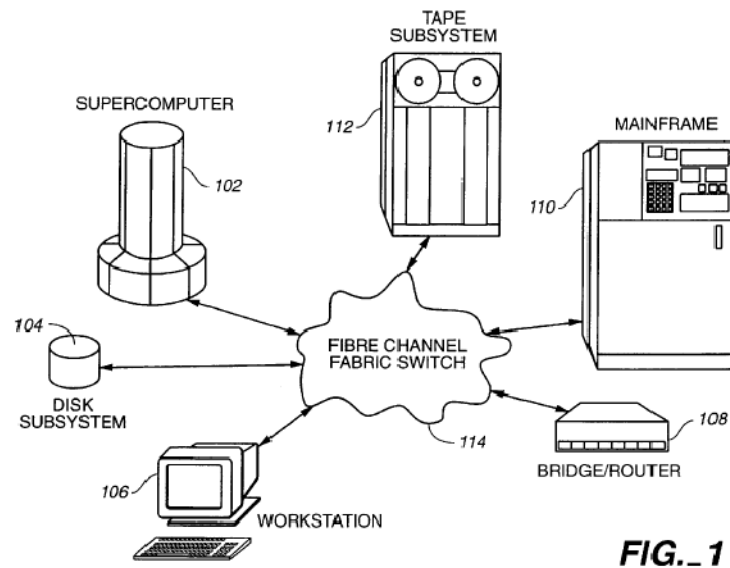
Vangemert discloses all element of Claim 1, with the possible exception of a “connector.” Reply at 17. Copeland teaches “connectors,” which is undisputed by PO. *Id.*

PO further confirmed that it would be obvious to combine the connectors of Copeland with Vangemert, as PO’s Exhibit 2012 expressly states it was known to use connectors with Fibre Channel systems. EX. 2012 at 1. PO does not dispute Petitioner’s combination of Copeland’s connectors with the system of Vangemert.

The combination of Vangemert and Copeland is therefore proper.

Vangemert/Copeland – Connector

Connector – Vangemert Teaching



Vangemert discloses a “serial link,” explaining that nodes 102, 104, 106, 108, 110, 112 of FIG. 1 are “coupled to a central ‘fabric switch’ 114 by a serial link having a receive channel and a transmit channel.” EX. 1005, col. 2:61-63. In another example, “the nodes are coupled in an ‘arbitrated loop’ topology, in which the transmit channel from one node is directly connected to the receive channel of the next node.” *Id.*, col. 3:5-7. A PHOSITA would have understood the FIG. 1 and FIG. 2 systems to require a connector to interconnect devices via the serial link, as described. EX. 1003, ¶ 46.

(Source: Pet at 22-23; EX1005 FIG. 1.)

Connector – Dr. Caloyannides Opinion on Vangemert Teaching Supported by PO Cited Reference

Dr. Caloyannides Opinion

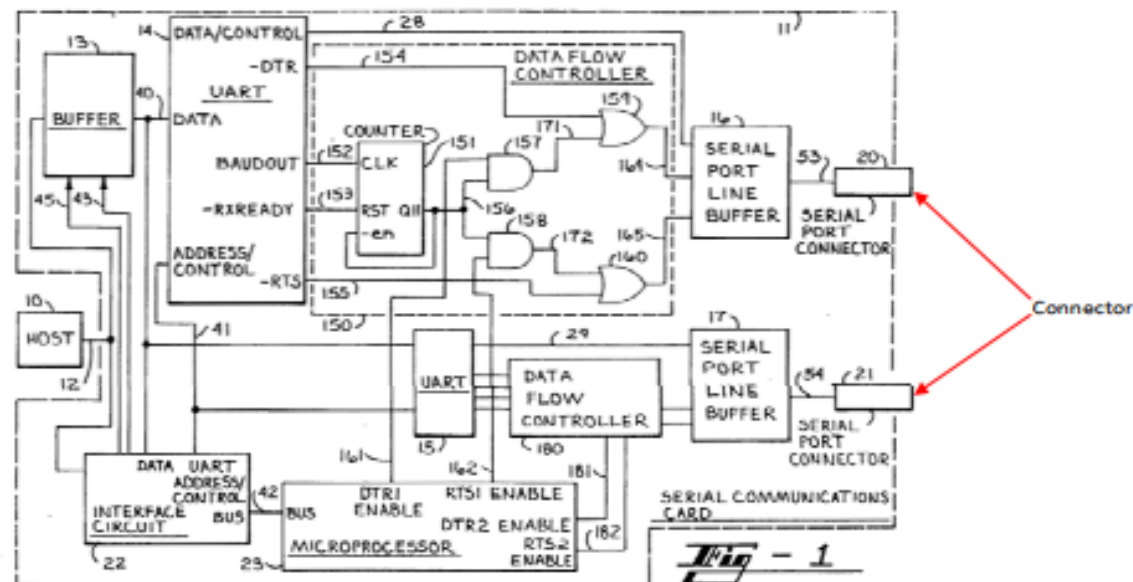
“From Vangemert, a PHOSITA would have appreciated that a connector would have been a required part of the system because connectors are generally known and widely used to efficiently create (implement) connections between components.” EX. 1003 at ¶46.

PO Cited Reference EX2012

“Another advantage of Fibre Channel is that it uses small connectors. The serial connectors used for Fibre Channel are a fraction of the size of SCSI parallel connectors and have fewer pins, thereby reducing the likelihood of physical damage. Also, depending on the topology, many more devices can be interconnected on Fibre Channel than on existing channels.” EX. 2012 at 1 (emphasis added).

Connector – Copeland Teaching

Copeland also teaches a connector connectable to a serial link. EX. 1003, ¶ 47. Copeland is directed to a dual channel asynchronous serial communications card 11 that includes “two serial port connectors 20 and 21.” EX. 1006, col. 3:49-60. Serial port connectors 20 and 21 are “connected to a communication device (not shown) such as a modem” and “preferably define an EIA RS-232-D serial interface.” EX. 1006, col. 4:31-34. RS 232-D connectors were well known in the art as common connectors for interconnecting serial devices. EX. 1003, ¶ 47. Copeland FIG. 1 shows connector 20 configured to connect the UART 14 with an external device via line 28. EX. *Id.* ¶ 48.



Copeland FIG. 1 (Annotated)

(Source: Pet. At 15-17; EX1006, col. 4:31-34.)

Vangemert and Copeland are Not Cumulative References

PO Incorrect Assertion that the Vangemert-Copeland References are Cumulative

As confirmed above, Vangemert teaches “generating a flow control signal in response to the amount of data stored in the first buffer equaling . . . The fill amount, and where the module is further configured to transmit the flow control signal through the serial link and the connector without passing the flow control signal through the second buffer.” Reply at 20-22.

In contrast, Szatkowski was asserted by Applicant in prosecution of the ‘454 Patent as failing to teach the above elements of Claim 1. *See*, Reply at 20; *see also*, EX. 1002 at 223-231.

As Vangemert teaches all elements of Claim 1, aside from the connector taught by Copeland, Vangemert therefore contains “a more complete combination of the claimed elements than any other reference before the examiner.” *See* MPEP 609.04(a), *see also*, Reply at 22.

Accordingly, Vangemert and Copeland are not cumulative references.

VANGEMERT UTILIZES FIFO BUFFERS

Vangemert Includes FIFO Buffers

Dr. Grimsrud testified that a PHOSTA would have “understood that the Vangemert transmit buffer was a FIFO buffer. See EX. 1013 at ¶ 25.

- This is corroborated by at least the Tachyon Article, which illustrates FIFO buffers being used for the buffers within the general Fibre Channel System, such as the “ACK FIFO” and Outbound FIFO (transmit buffer). See EX. 1013 at ¶35; *see also* EX. 1014 at FIGS. 4-6.
- Further corroboration can be found in PO’s EX. 2007, describing the use of FIFO buffers within a Fibre Channel system. EX. 2007, at 1125-1126.
- As confirmed by Mr. Lee, Fibre Channel is a standardized protocol. See EX. 2002 at ¶ 99.

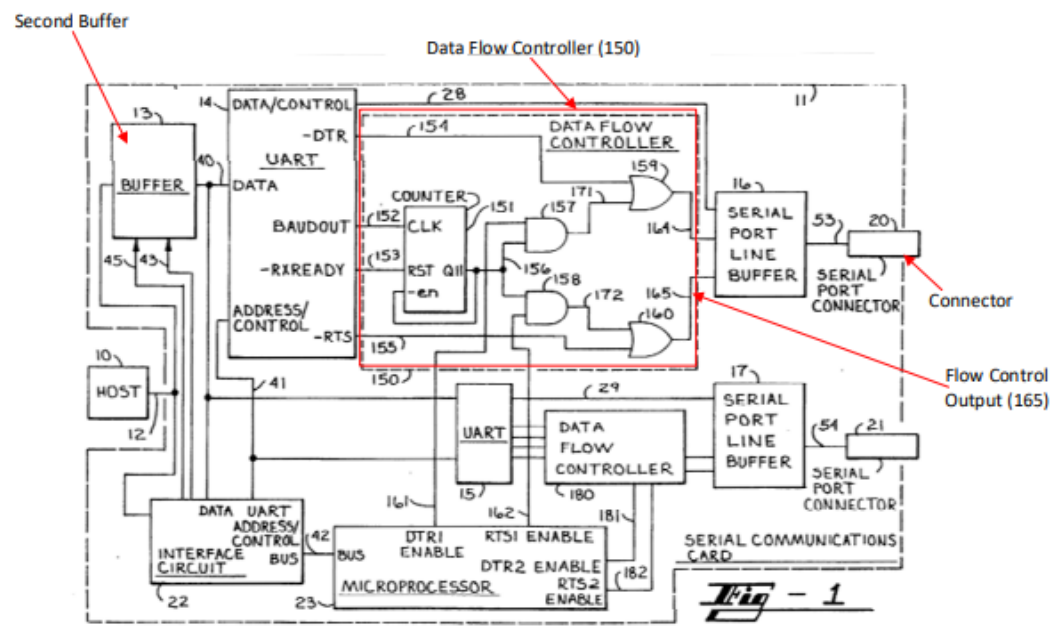
Dobson/Copeland – Flow Control Transmission

Dobson/Copeland – Flow Control Generation

Flow Control Generation – Copeland Teaching

Copeland expressly teaches generating “a flow control signal in response to the amount of data stored in the first buffer equaling or exceeding the fill amount.” See, Pet. At 61-62.

Flow control is activated when the FIFO buffer “is forty percent full” [equal to fill amount], and a low value is output on the Request to Send line [flow control signal] which is output to the serial link (RS-232) via the serial port connector 20. EX. 1006 at 5:22-55.



Copeland FIG. 1 (Annotated)

Flow Control Generation – Copeland – Dr. Caloyannides Opinion

- Dr. Caloyannides testified that Copeland teaches that data flow control is activated upon the FIFO buffer being forty percent full. EX. 1003 at ¶ 140.
- PO does not rebut Dr. Caloyannides (or Petitioner's) above positions regarding the teaching of Copeland.

Flow Control Generation – PO Misrepresents Petitioner’s Use of Dobson

The POR incorrectly asserts that Petitioner “attempts to map Dobson’s IRQ signal to the flow control signal recited in the claims. As explained below, that mapping fails because there is no evidence that Dobson’s IRQ signal is transmitted through the serial link.” POR at 38.

- PO misrepresents Petitioner’s position, which is that Copeland teaches generating a flow control signal, and ultimately transmitting said flow control signal over a serial link, as discussed above. *See*, Pet at 61-66.
- Dobson was used at most to show that it also taught flow control mechanisms, but Petitioner never asserted that the IRQ signal of Dobson was transmitted over the serial link. *See*, Pet at 65-66.

Dobson/Copeland – Flow Control Transmitted over Serial Link

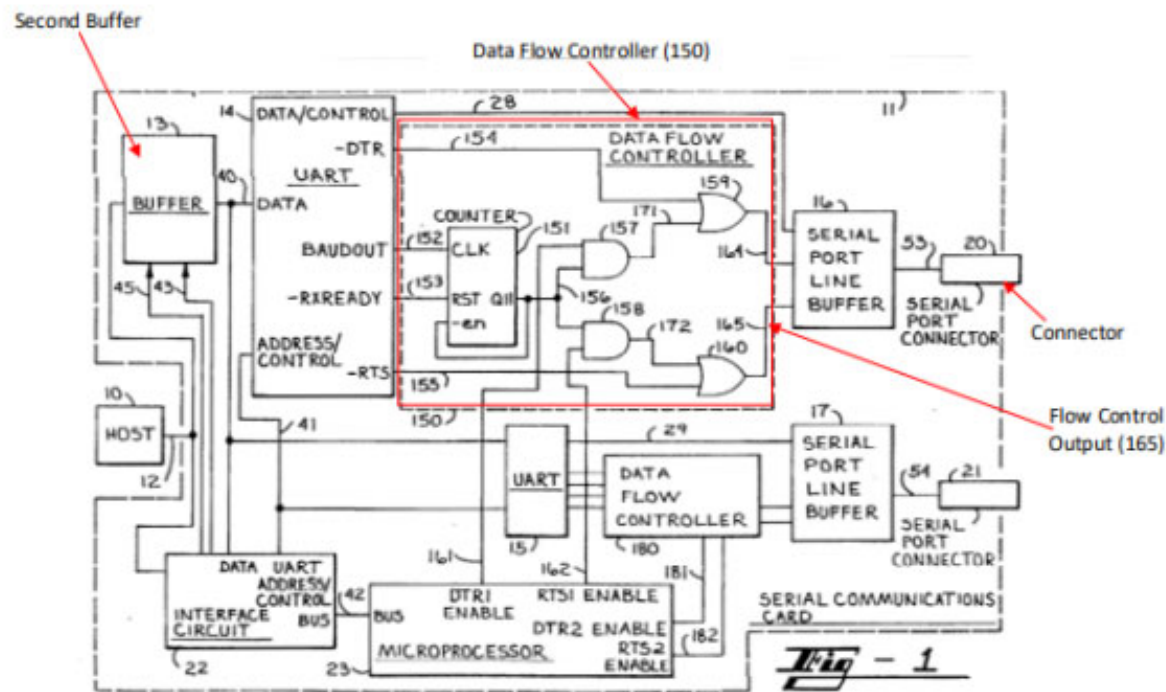
Flow Control Transmitted over Serial Link – PO Improperly Interprets “Serial Link” of Claim 1

PO attempts to read in limitations to the claimed “serial link,” stating that the “serial link” of claim is the “data connection that carries both the serial data and the flow control signal,” and then confusingly states that with respect to RS232, “a bundle of nine physical wires are included in the connector (e.g., DB9). However, only two of the wires carries that serialized data that form the claimed serial link.” Sur-Reply at 21.

However, Copeland teaches that all data, including data and flow control signals are provided to the connector and then through the serial connection to a remote device, thereby forming a “data connection that carries both the serial data and the flow control signal.” See, EX. 1006 at 4:22-55; see *also* Reply at 25-26.

Flow Control Transmitted Over Serial Link – Copeland Teaches

- The flow control signal 165 of Copeland passes through the serial port line buffer 16 and is output to the serial link via the connector 20. *See, Reply at 25; see also, EX. 1006, 4:22-38.*



EX1006, FIG. 1