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(54) **INTELLIGENT CONTROL AND MANAGEMENT MATRIX, APPARATUS, SYSTEM, AND A METHOD THEREOF**

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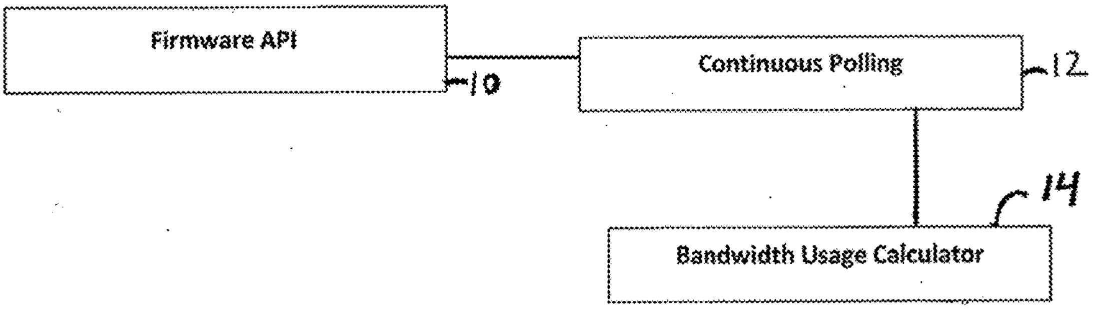
(57) **ABSTRACT**

The present invention relates generally to an intelligent control and management matrix (ICMM), apparatus, system, and a method thereof. More particularly, the invention encompasses an inventive intelligent control and management matrix (ICMM), or icXengine, which is designed to help resolve a consistent issue seen in packet transmission technology, such as, for example, Ethernet technology, which is called contention. In one aspect the inventive ICMM, monitors, polls, and acts based on traffic flow information, to reduce contention, and to allow more data, video, voice, user content, etc., to pass through the Ethernet system. Thus, the inventive ICMM or icXengine allows for decision making, and traffic policing, based on bandwidth analytics, and a predetermined formulation or criteria.



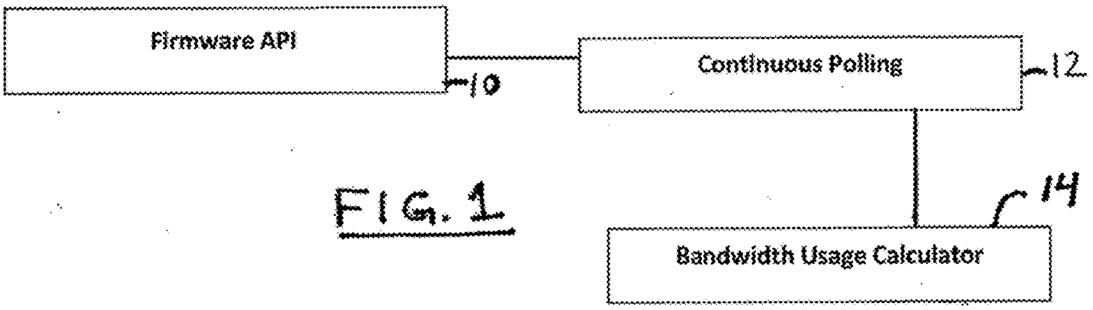

Firmware API
10
Continuous Polling
12
14
Bandwidth Usage Calculator

FIG. 1

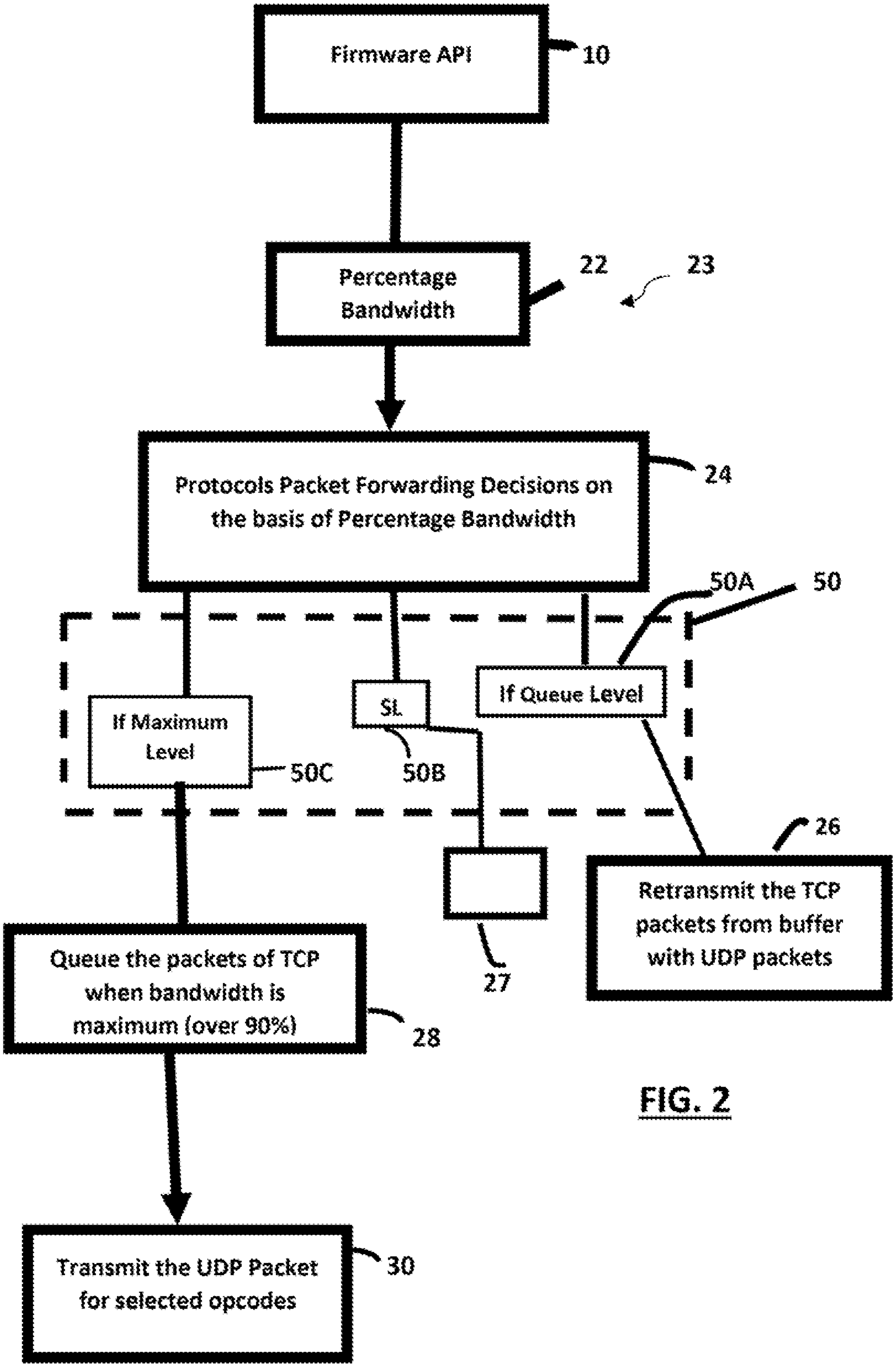

Firmware API
10
Percentage Bandwidth
22
23
Protocols Packet Forwarding Decisions on the basis of Percentage Bandwidth
24
50A
50
If Queue Level
SL
If Maximum Level
50C
50B
26
Retransmit the TCP packets from buffer with UDP packets
27
Queue the packets of TCP when bandwidth is maximum (over 90%)
28
Transmit the UDP Packet for selected opcodes
30

FIG. 2

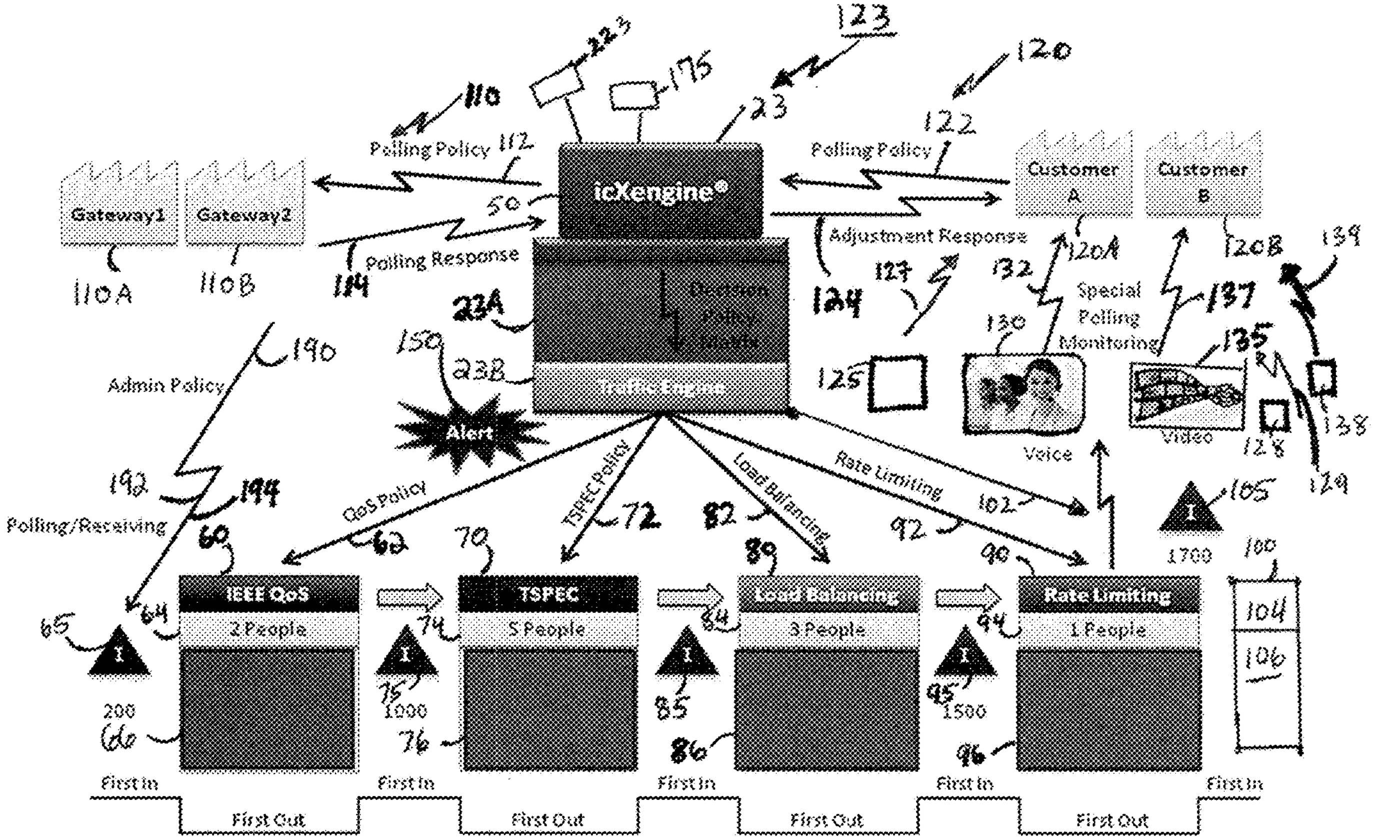
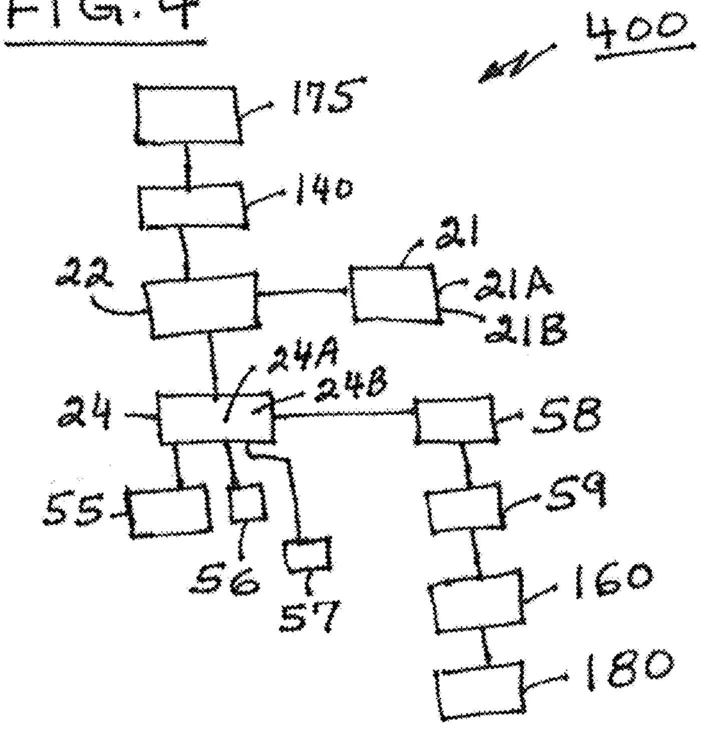

223
175
110
23
123
120
Polling Policy 112
Polling Policy
122
icXengine®
50
Gateway1
Gateway2
Customer A
Customer B
Polling Response
114
110A
110B
Adjustment Response
124
127
132
120A
120B
139
Special Polling Monitoring
137
135
Decision Policy Matrix
Traffic Engine
23A
23B
150
Alert
125
130
Voice
Video
128
138
129
Admin Policy
190
192
194
Polling/Receiving
QoS Policy
62
TSPEC Policy
72
82
Load Balancing
89
Rate Limiting
102
92
90
105
1700
100
104
106
60
70
65
64
IEEE QoS
2 People
TSPEC
5 People
74
Load Balancing
3 People
84
Rate Limiting
1 People
94
I
200
66
75
1000
76
85
86
95
1500
96
First In
First Out

FIG. 3

FIG. 4



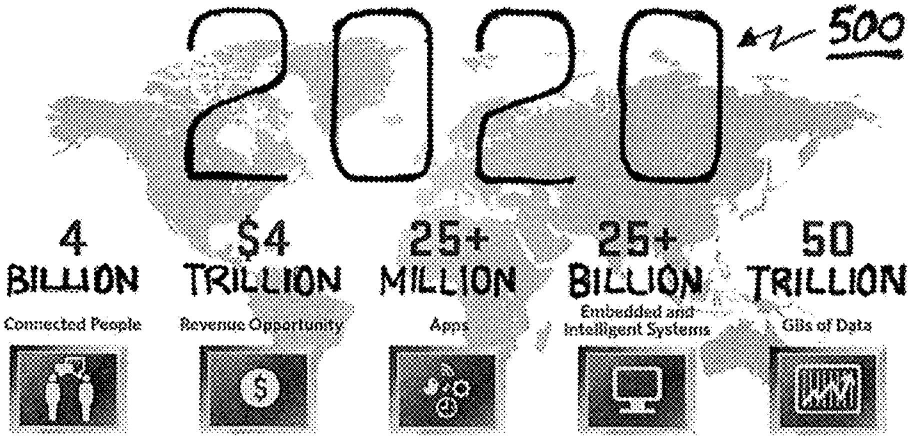


Figure 5

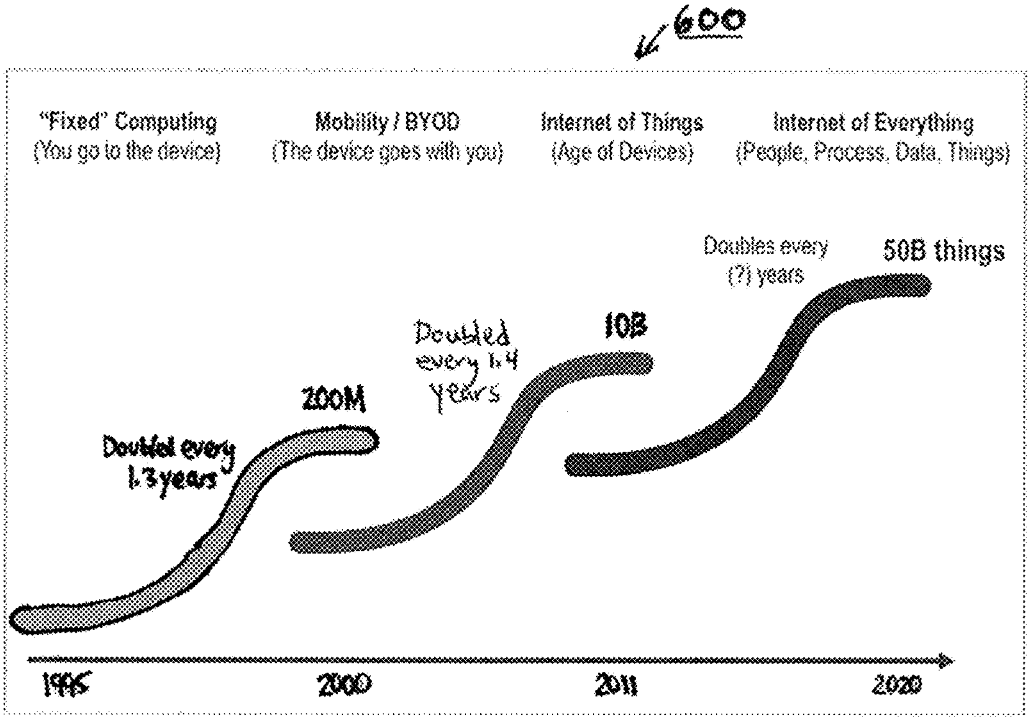


Figure 6

INTELLIGENT CONTROL AND MANAGEMENT MATRIX, APPARATUS, SYSTEM, AND A METHOD THEREOF

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The instant patent application claims priority to and the benefit of U.S. Provisional Patent Application Ser. No. 62/303,624, filed on Mar. 4, 2016, titled "Intelligent Control and Management Matrix, Apparatus, System, and a Method Thereof," the entire disclosure of which provisional application is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates generally to an intelligent control and management matrix (ICMM), apparatus, system, and a method thereof. More particularly, the invention encompasses an inventive intelligent control and management matrix (ICMM), or icXengine, which is designed to help resolve a consistent issue seen in packet transmission technology, such as, for example, Ethernet technology, which is called contention. In one aspect the inventive ICMM, monitors, polls, and acts based on traffic flow information, to reduce contention, and to allow more data, video, voice, user content, etc., to pass through the Ethernet system. Thus, the inventive ICMM or icXengine allows for decision making, and traffic policing, based on bandwidth analytics, and a predetermined formulation or criteria.

PURPOSES AND SUMMARY OF THE INVENTION

[0003] The invention is a novel intelligent control and management matrix, apparatus, system, and a method thereof.

[0004] Therefore, one purpose of this invention is to provide an apparatus which allows for monitoring, polling, and acting based on traffic flow information, to reduce contention, and to allow more data, video, voice, user content, etc., to pass through an Ethernet system.

[0005] In one aspect this invention comprises a method for controlling data packet transmission in a data network of a communication system comprising:

[0006] defining a first level of packet transmission rate, which first level establishes a queue system for lower priority data packets based on one of at least one first criteria calculations, and at least one second criteria calculations;

[0007] defining a second level of packet transmission rate, which second level diverts lower priority data packets into said queue system based on type of data packet;

[0008] defining a third level of packet transmission rate, which third level diverts lower priority data packets into said queue system based on protocol precedence of data packet;

[0009] transmitting data packets over a data network;

[0010] determining rate of data packet transmission over said data network;

[0011] determining type of data packet transmitted over said data network;

[0012] responsive to a packet transmission rate exceeding said first level, establishing a queue system for lower priority data packets based on said one of at least one first criteria calculations, and at least one second criteria calculations;

[0013] responsive to a packet transmission rate exceeding said second level, diverting lower priority data packets into said queue system based on type of data packet; and

[0014] responsive to a packet transmission rate exceeding said third level, diverting lower priority data packets into said queue system based on protocol precedence of data packet.

[0015] In another aspect this invention comprises a system for controlling data packet transmission in a data network of a communication system comprising:

[0016] defining a first level of packet transmission rate, which first level establishes a queue system for lower priority data packets based on one of at least one first criteria calculations, and at least one second criteria calculations;

[0017] defining a second level of packet transmission rate, which second level diverts lower priority data packets into said queue system based on type of data packet;

[0018] defining a third level of packet transmission rate, which third level diverts lower priority data packets into said queue system based on protocol precedence of data packet;

[0019] transmitting data packets over a data network;

[0020] determining rate of data packet transmission over said data network;

[0021] determining type of data packet transmitted over said data network;

[0022] responsive to a packet transmission rate exceeding said first level, establishing a queue system for lower priority data packets based on said one of at least one first criteria calculations, and at least one second criteria calculations;

[0023] responsive to a packet transmission rate exceeding said second level, diverting lower priority data packets into said queue system based on type of data packet; and

[0024] responsive to a packet transmission rate exceeding said third level, diverting lower priority data packets into said queue system based on protocol precedence of data packet.

[0025] In yet another aspect this invention comprises a non-transitory computer-readable storage medium with an executable program application stored thereon, the program application configured for controlling data packet transmission in a data network, the program application configured to be accessible over a communications network, wherein the program application instructs a computer processor to perform the following steps of:

[0026] defining a first level of packet transmission rate, which first level establishes a queue system for lower priority data packets based on one of at least one first criteria calculations, and at least one second criteria calculations;

[0027] defining a second level of packet transmission rate, which second level diverts lower priority data packets into said queue system based on type of data packet;

[0028] defining a third level of packet transmission rate, which third level diverts lower priority data packets into said queue system based on protocol precedence of data packet;

[0029] transmitting data packets over a data network;

[0030] determining rate of data packet transmission over said data network;

[0031] determining type of data packet transmitted over said data network;

[0032] responsive to a packet transmission rate exceeding said first level, establishing a queue system for lower priority data packets based on said one of at least one first criteria calculations, and at least one second criteria calculations;

[0033] responsive to a packet transmission rate exceeding said second level, diverting lower priority data packets into said queue system based on type of data packet; and

[0034] responsive to a packet transmission rate exceeding said third level, diverting lower priority data packets into said queue system based on protocol precedence of data packet.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] FIG. **1**, illustrates an overview of a relationship between a firmware API and a bandwidth usage calculator.

[0036] FIG. **2**, illustrates a flow chart of an inventive icXengine module according to a first embodiment of the invention.

[0037] FIG. **3**, illustrates an inventive ICMM or icXengine which constantly monitors, polls, measures, and adjusts the various inputs and outputs to decide how to handle traffic flows with respect to the environment and associated functional modules according to a second embodiment of the invention.

[0038] FIG. **4**, illustrates a flow chart of some of the inventive components of the inventive ICMM or icXengine according to a third embodiment of the invention.

[0039] FIG. **5**, illustrates how the IOT (Internet of Things) has a global impact.

[0040] FIG. **6**, illustrates how Internet of Things (IOT) continues to speed up over time, complexity of content, and type of use.

DETAILED DESCRIPTION

[0041] The inventive intelligent control and management matrix, apparatus, system, and a method thereof will now be discussed with reference to FIGS. **1** through **6**. Although the scope of the present invention is much broader than any particular embodiment, a detailed description of the preferred embodiment follows together with drawings. These drawings are for illustration purposes only and are not drawn to scale. Like numbers represent like features and components in the drawings.

[0042] As we move towards a super hyper-connected world, a different use for software emerges as a way to dynamically handling some of the various routing, management, and other data control points of the network. Adding some of the intelligence from the data plane, software-driven systems will unlock the pent up efficiency that is held-up by traditional data network ecosystems. Driven by demand, the networks have proven to be one of the few major bottlenecks as users demand more communication and content services. Software-driven networks provide tools to route and create virtual environments, and they continue to become a real option for optimization, deployment, and management for more network environments. Additionally, with the combination and consolidation at the client level has resulted in reducing the client network ecosystem footprint while obtaining additional savings and green energy advantages.

[0043] Therefore, a major impact in the adoption of technology as a medium for communication is its ease-of-use and interfacing between a gateway and a user or client. The icXengine is designed to make it easier for users to communicate to a gateway and to reduce contention. This invention provides a polling mechanism to provide priority or fast connectivity to a user, or a customer, or a device.

[0044] The current Ethernet methodology for transmissions is called Carrier Sense Multiple Access with Collision Detection (CSMA/CD).

[0045] Carrier Sense Multiple Access with Collision Detection (CSMA/CD) is a media access control method used most notably in local area networking (LAN) using early Ethernet technology. It uses a carrier sensing scheme in which a transmitting data station detects other signals while transmitting a frame, and stops transmitting that frame, transmits a jam signal, and then waits for a random time interval before trying to resend the frame. Carrier Sense Multiple Access with Collision Detection (CSMA/CD) is a modification of pure Carrier Sense Multiple Access (CSMA). Carrier Sense Multiple Access with Collision Detection (CSMA/CD) is used to improve CSMA performance by terminating transmission as soon as a collision is detected, thus shortening the time required before a retry can be attempted.

[0046] The assumption of Carrier Sense Multiple Access with Collision Detection (CSMA/CD) is that collisions will happen and therefore, retransmissions are necessary to ensure delivery of data packets. Since collisions were designed into the system to handle and ensure delivery of content, then the more devices and data on the local area network (LAN), the more chances for collisions which means contention will continue to grow. This is similar to like having too many cars in a traffic jam, and the easiest way to resolve the issue is to make a wider freeway to avoid traffic jams. However, to avoid such data jams on a network, the most common mode so far has been to increase the data speeds and go from, for example, to 10 mbps, to 100 mbps, to 1000 mbps, to 10 Gbps, and so on, or create more intelligence at nodes and at data level to handle the movement of data traffic.

[0047] There are several methods being used attempting to increase the existence of usable IP (Internet Protocol) bandwidth, such as, for example:

[0048] 1. Upgrading the network is one method. Once a user's network slows (seemingly always around the 3-5 year upgrade cycle) they must upgrade to a higher capacity network.

[0049] 2. Quality-of-Service (QoS), a standard with IEEE and primarily a static method has also been used and changed to be more efficient by various groups.

[0050] 3. Software Defined Networking (SDN) theory is to remove all intelligence from the local area network (LAN) and centralizing it in a hardware or cloud controller which centrally tells local traffic where to go. This is designed for deployment efficiency and control.

[0051] Some other methods try to overlay more software to monitor the network and attempt to try and create efficiencies, but these simply add more data to an already crowded IP Data Network.

[0052] All the known methods accept the fact that Ethernet has to be filled with contention, dropped packets, and by accepting that, they design methods that try to go around contention. Also, these known methods attempt to deal with different issues than allowing more IP traffic onto the deployed network because as network vendors, they need to increase sales over time while not threatening existing install base. The other down side of the known existing methods is that they are primarily static in nature. For example, the Quality-of-Service (QoS) methodologies widely accepted in marketplace come up with a simple game plan prior to the game being played and cannot adjust accordingly to the changing nature of the realities on the ground. They try to employ more of a "One Size Fits All" methodology. Another reason for limited results is that the existing known methods were not designed as a tool for mass consumption. For example, SDN (Software Defined Networking) is really for Data Center and high end computing and deployment, and not for the small LAN (Local Area Network).

[0053] While the internal working processes are complex, the user interface and actions to set up the apparatus are very simple, as more clearly shown and described in FIGS. **1**, through **6**.

[0054] Some of the advantages provided by this invention are, for example, it is a software driven solution for an existing problem. It reduces time spent for set-up and deployment, as it is a simple interface, which substantially increases traffic flow. This invention also reduces the cost of preparation for networking installations, and thus reduces total operating expenditures. It provides a faster time to deployment by automating the hyper-terminal setup and connection, log in, along with the system status checks. It increases the use of higher end networking devices, and thus improves on performance and return on investment for a user or client. This invention also opens up the historically proprietary nature of vendor data networking devices to a faster configuration and setup.

[0055] The inventive ICMM or icXengine system or platform of this invention has value for various industry segments, such as, for example, it reduces client or user or device deployment times, and increases deployment efficiency, while reducing technical setup and training time and requirements. It also simplifies training for a third party vendor or installer, and reduces specialized trainings as it is substantially software driven.

[0056] The inventive ICMM or icXengine system or platform of this invention has also value for users or customers, as it reduces operational expenses due to lower installation costs, and it increases cash for capital expenditures. For a user or a customer or a device it also reduces down time and increased workable use time, and it has exponential value as the deployment increases in size and complexity. It also seeks to eliminate the complexity of user connection to their enterprise networking device or devices.

[0057] The industry value from this invention increases because as connectivity demands increases, the handling of the data traffic requires more complex systems and software. This inventive system reduces the complexity and barriers to handling those complex environments. Also, by reducing the initial complexity, this invention enables user to access higher end technology that then ensures delivery of their content.

[0058] FIG. **1**, illustrates an overview of a relationship between a firmware application program interface (API) **10**, and segments of the inventive icXengine comprised of polling module **12** and bandwidth usage calculator **14**. The application program interface (API) **10**, is a set of routines, protocols, and tools for building software applications. An API **10**, specifies how software components should interact. As illustrated in FIG. **1**, the inventive polling module of icXengine **12**, does periodic polling **12**, or continuous polling **12**, via the firmware API **10** and uses a bandwidth usage calculator **14**, to identify or classify the polling results **12**.

[0059] FIG. **2**, illustrates a flow chart of a firmware application program interface (API) **10**, module according to a first embodiment of the invention. The inventive icXengine through the firmware API interaction **10**, gets the polling results **12**, and then based on criteria **22**, **50**, which is preferably a percentage bandwidth **22**, **50**, allows the processing of the packets at step **24**. For example, at step **24**, the protocol forwarding decisions on the basis of percentage bandwidth **24**, could be based on, for example, first level or Queue Level (QL-60%) **50**A, second level or Stepped Level (SL-75%) **50**B, third level or Maximum Level (ML-90%) **50**C, to name a few, as established by an operator **223**. Thus, for example, for first level or Queue Level (QL-60%) **50**A, one would retransmit the Transmission Control Protocol (TCP) packets from buffer with User Datagram Protocol (UDP) packets at step **26**. For the second level or Stepped Level (SL-75%) **50**B, one could have a criteria that is in-between the first level or Queue Level (QL-60%) **50**A, and the third level or Maximum Level (ML-90%) **50**C, at step **27**. For the third level or Maximum Level (ML-90%) **50**C, one would queue the packets of Transmission Control Protocol (TCP) when bandwidth is maximum, for example, over 90 percent, at step **28**. Thus, at step **28**, one would transmit the User Datagram Protocol (UDP) packet for selected opcodes at step **30**.

[0060] FIG. **3**, illustrates an inventive intelligent control and management matrix (ICMM) **23**, or icXengine **23**, which constantly monitors, polls, measures, and adjusts the various inputs and outputs to decide how to handle traffic flows according to a second embodiment of the invention. The inventive intelligent control and management matrix (ICMM) **23**, interacts with at least one gateway **110**, using polling policy **112**, and getting a polling response **114**. For the purposes of illustration the at least one gateway **110**, is shown as gateway **1 110**A, and gateway **2 110**B. It should be appreciated that the at least one gateway **110**, could be firewall **110**, or entry point **110**, to name a few. The inventive intelligent control and management matrix (ICMM) **23**, or icXengine **23**, also interacts with at least one user **120**, or client **120**, or customer **120**, or device **120**, using polling policy **122**, and adjusting response **124**. For the purposes of illustration the at least one user **120**, or client **120**, or customer **120**, or device **120**, is shown as customer A **120**A, and customer B **120**B. The at least one user **120**, or client **120**, or customer **120**, or device **120**, could be using voice **130**, via at least one communication means **132**, and/or a video stream **135**, via at least one communication means **137**, and/or data **125**, via at least one communication means **127**, and/or a gaming stream **138**, via at least one communication means **139**, and/or a mission critical **128**, via at least one communication means **129**. The inventive intelligent control and management matrix (ICMM) **23**, or icXengine **23**, further comprises of a decision policy matrix **23**A, and a traffic engine **23**B. The inventive intelligent control and management matrix (ICMM) **23**, or icXengine **23**, does periodic or continuous polling **192**, and receives the polling results **194**, and then uses the admin policy **190**, to implement the pre-established criteria for traffic or packet flow through the Ethernet system **123**. The periodic or continuous polling **192**, could be done for a Quality-of-Service (QoS) **60**, via a Quality-of-Service policy **62**, a Traffic Specification (TSPEC) **70**, via a TSPEC policy **72**, a Load Balancing **80**, via a Load balancing policy **82**, a Rate Limiting **90**, via a rate limiting policy **92**, other criteria **100**, via another criteria policy **102**. For the purposes of illustration for Quality-of-Service (QoS) **60**, one could have 2 people **64**, or devices **64**, in the queue and the QoS polling & policing **66**, could be done for example, 200 times, and/or for Traffic Specification (TSPEC) **70**, one could have 5 people **74**, or devices **74**, in the queue and the Traffic Specification (TSPEC) polling and policing **76**, could be done for example, 1000 times, and/or for Load Balancing **80**, one could have 3 people **84**, or devices **84**, in the queue and the Load Balancing polling and policing **86**, could be done for example, 0 times, and/or for Rate Limiting **90**, and one could have 2 people **94**, or devices **94**, in the queue and the Rate Limiting polling and policing **96**, could be done for example, 1500 times, and/or for others **100**, one could have x number of people **104**, or devices **104**, in the queue and the other polling and policing **106**, could be done for example, y number of times. For some application one could have a system alert **150**, and/or Quality-of-service (QoS) alert **65**, and/or Traffic Specification (TSPEC) alert **75**, and/or Load Balancing alert **85**, and/or Rate Limiting alert **95**, and/or other alert **105**. It should be appreciated that all of these alerts are taken into account by the inventive intelligent control and management matrix (ICMM) **23**, or icXengine **23**, and individual policies are adjusted accordingly.

[0061] FIG. **4**, illustrates a flow chart **400**, of some of the inventive components of the inventive ICMM **23**, or icXengine **23**. The inventive intelligent control and management matrix (ICMM) **23**, or icXengine **23**, essentially has three key components, namely, analytics **140**, decision making **160**, and traffic policing **180**.

[0062] As illustrated in flow chart **400**, for the analytics component **140**, at a first step **22**, of the icXengine **23**, one processes dynamic bandwidth calculation to calculate the total uplink bandwidth **21**A, and total downlink bandwidth **21**B, availability of the uplink/downlink link **21**, and then one runs it intelligently until one has enough data points to run a statistical analysis on the total availability of the bandwidths **21**A, **21**B.

[0063] In a second step **24**, the next algorithm of calculation of actual uplink **24**A,/downlink **24**B, port utilization bandwidth is to be executed. This will calculate the bandwidth usage **24**A, **24**B, from the total bandwidth **24**A, **24**B, in percentage based on a predetermined formula **50**. This formula **50**, maybe applied to uplink **21**A, downlink **21**B, and combined bandwidth **21**A, **21**B, for specific utilization and key decisions that will be discussed later. At cold reboots this bandwidth check will be performed after a set interval of time or sample interval (SI) **55**, allowing for the traffic patterns **56**, to establish themselves to root out any incorrect data collection.

[0064] For the purposes of illustration in a very rudimentary implementation form, three levels of bandwidth Utilization Percentage (UP) **50**, can be selected, as follows:

[0065] (a) First level or Queue Level (QL-60%) **50**A;

[0066] (b) Second level or Stepped Level (SL-75%) SOB; and

[0067] (c) Third level or Maximum Level (ML-90%) **50**C.

[0068] The calculations of the actual port bandwidth Utilization Percentage (UP) **50**, can also be performed, for example, at set intervals of times **55**, multiple times **55**, of the day, to name a few. The calculations of the actual port bandwidth Utilization Percentage (UP) **50**, can also be performed, for example, using a sample size (SS) **57**. Once a utilization trend is noticed and learned by the inventive ICMM **23**, or icXengine **23**, the frequency of the checks **55**, **57**, etc., could be adjusted accordingly. It should be appreciated that the maximum polling time would be based on different real time bandwidth testing and results. After testing of real bandwidth one would set the general polling time **58**, which will be workable for most all scenarios.

[0069] An overall evaluation and analysis of the high-level traffic flow patterns and protocols would be kicked-offright after reboot and would follow and utilize traffic flow protocols like, for example, sFlow **100**, if applicable. The traffic pattern **56**, evaluation decision will be updated on a real-time basis. Some part of this analysis may or may not be performed on an external device **175**. After the initial analysis the forwarding decision of subsequent protocol packets will be based on the basis of Utilization Percentages (UP) **50**, high-level traffic analytics **140**, and deep sample packet analysis (SPA) **59**.

[0070] As the Utilization Percentage **50**, for example, crosses the Queue Level (QL) mark **50**A, a lower level sample-packet analysis (SPA) **59**, will start to kick off only at that moment to limit the overhead to a minimum. This will basically be a per packet inspection but at certain sample intervals and will be based on sampling theorems or formula **50**. This sample packet analysis **59**, will be in addition to the high-level analytics **50**, that were performed automatically from the cold boot as discussed earlier. This SPA **59**, will also utilize the high-level analytics **59**, in conjunction with the sampling theorems **50**, to select the right sample size (SS) **57**, and/or the sample interval (SI) **55**. This is referred to as the analytics piece **140**, of the inventive icXengine **23**.

[0071] Precedence of protocols can now be set on the basis of bandwidth Utilization Percentages (UP) or formula **50**. The precedence will be changed according to the bandwidth usage **21**, on a real-time basis. This is the second phase of the inventive icXengine **23**, design covering the decision making section **160**.

[0072] When Utilization Percentages (UP) **50**, reaches the second level or Stepped Level (SL) mark **50**B, the first phase of Traffic Policing (TP) **180**, and the third and final phase of inventive icXengine **23**, design will come into effect. Here the complete non-real-time traffic User Datagram Protocol (UDP) type packets will start getting into, for example, FIFO (first in, first out) queues based on protocols **50**, and a BandWidth allocation for them can now be enforced. This allocation **50**, will be calculated on a real-time basis pivoting on the total available WAN link bandwidth **21**, and the User Datagram Protocol (UDP) Packet Type Queue (PTQ) it belongs to. All other application specific User Datagram Protocol (UDP) session packets like DHCP etc., packets will still be allowed through without being put into queues.

[0073] When bandwidth **21**, consumption is above the third level or Maximum Level limit **50**C, then the next phase of traffic policing (TP) **180**, will kick into effect. Certain Transmission Control Protocol (TCP) packets will be queued in a different buffer for later sequenced and/or selective transmission. Also when all real-time User Datagram Protocol (UDP) packets come, then precedence level of User Datagram Protocol (UDP) packets will be checked against the precedence protocol **50**, set in place. For instance, when User Datagram Protocol (UDP) packets of voice **130**, and User Datagram Protocol (UDP) packets of other real time transmission **135**, arrive at the same time, then the precedence level **50**, is checked and accordingly executed.

[0074] Transmission Control Protocol (TCP) buffer length per type of packet and protocol will have to be set accordingly not to drop sessions altogether. A deep TCP packet inspection **59**, is in place to identify all new session creation requests based on the application to be used. All application creation request/reply TCP packets will be deemed higher priority and allowed to pass through while the keep-alive TCP packets of existing sessions will be put in the buffer based on their max timeout values. A Fair Queuing or round robin type mechanism is put in place for this buffer so these packets or a selection of these packets are forwarded after max peak wait time (PWT) in the queue. The peak wait time (PWT) formula will be expanded up on later as it depends up on the type of session and application that the TCP packets belong to. All non-real-time User Datagram Protocol (UDP) data packets **125**, will also follow a fair queuing/round robin mechanisms and associated bandwidth **21**, will be allocated for them as well for their particular queue.

[0075] After bandwidth level **21**, comes back below the second level or Stepped Level (SL) **50**B, packets that were queued on the buffer will start forwarding normally again and no new packets will be placed in any queues.

[0076] All of the icXengine **23**, mechanisms are designed not to replace but to complement the legacy QoS **60**, and bandwidth management processes in place. Any traffic that matches a typical QoS rule or policy **62**, will be allowed to go through according to the priority set in place for that type of traffic. Alternatively and preferably, the user **120**, can further enhance the network performance **123**, by layering the icXengine **23**, processes on top of the legacy QoS rules or policy **62**, configured in place.

[0077] For the purposes of illustration let us assume that we are operating below the first level or Queue Level (QL) **50**A, and hence all types of traffic or data packet transmission is allowed to go through. The data network or system **123**, is utilizing the high level traffic pattern or data packet transmission analysis to see and create some base criteria for what is anticipated. Once the traffic or data packet transmission goes above the first level or Queue Level (QL) **50**A, the system **123**, starts the inventive ICMM **23**, or icXengine **23**, calculations based on a prior high-level analytics that have already been stored in the system **123**, by an operator **223**, and decide on a sample packet analysis (SPA) **59**, for packet level analytics based on a calculated sample size (SS) **57**, and/or sample interval (SI) **55**. Based on these calculations, the inventive ICMM **23**, or icXengine **23**, kicks in the decision making process and starts creating queues.

[0078] Now as the traffic or data packet transmission goes above the second level or Stepped Level (SL) SOB, the icXengine traffic policing **66**, **76**, **86**, **96**, **106**, kicks in and starts diverting the lower priority traffic or data packet transmission into those queues in a manner which is according to type of packets being received. The decision engine **23**, at this point also starts calculating the bandwidth that this lowest priority traffic or data packet transmission will be allowed. This lowest priority traffic or data packet transmission is typically the common web browsing traffic, email traffic, social media traffic, and other peer-to-peer/peer-to-multi-peer traffic **125**, sharing type, and is mostly comprised of User Datagram Protocol (UDP) packets. However, the higher priority traffic **128**, **130**, **135**, **138** continues to flow without any contention in the second level or Stepped Level **50**B, phase.

[0079] When the overall traffic or data packet transmission starts to increase and it surpasses the third level or Maximum Level (ML) **50**C, bandwidth usage, the next step of the icXengine policing **66**, **76**, **86**, **96**, **106**, starts to be implemented. At this point as both User Datagram Protocol (UDP) and Transmission Control Protocol (TCP) packets that arrive at the device for further processing are looked at and further segmentation of traffic or data packet transmission starts to happen on the basis of protocol precedence. In this case, the inspection extends to the type of application level to prioritize traffic or data packet transmission between different forms of real-time traffic **130**, **135**, **138**, and other mission critical data **128**. The lower protocol packet types **125**, will now be placed into their own queues for phased transmissions. So, for example, if mission critical traffic or packet **128**, voice traffic or packet **130**, multi-media streaming traffic or packet **135**, and some gaming application traffic or packet **138**, comes in, mission critical traffic or packet **128**, voice traffic or packet **130**, and gaming traffic or packet **138**, will pass through, but the multi-media streaming data traffic or packet **135**, and/or signaling traffic will be placed in specialized priority queue buffers for all such session traffic that will allow it to go through at lower interval rates that has negligible effect to the user **120**. Also in this case the TCP signaling keep-alive traffic or packets would start to queue in the buffer as well, but will be allowed to pass through in a manner that does not cause the session to timeout for that application.

[0080] As bandwidth starts to minimize and reaches below the third level or Maximum Level (ML) **50**C, then at that point all the TCP packets and other real-time time traffic **130**, **135**, **138**, and mission critical **128**, which were queued in buffers will start forwarding without any additional interval. Once the bandwidth usage continues to drop and reaches below the second level or Stepped Level (SL) **50**B, then all the other lower priority traffic **125**, placed into those queues will start flowing normally rather than following the limited bandwidth allocated to that type of traffic. The monitoring of bandwidth will continuously poll to get real time usage so that the data monitoring and packet transmission can be adjusted in real time.

[0081] This way the real-time intelligent ICMM **23**, or icXengine **23**, mechanism put in place will be able to dynamically route traffic or data packet transmission according to the deep packet level analytics designed and put into place. All of the inventive ICM **23**, or icXengine **23**, mechanisms are not designed to replace the conventional QoS structures **60**, in place but actually work in conjunction with the regular QoS **60**, and ACL **110** type of rules configured by the network administrators **223**. Since legacy configurable QoS **60**, is only set on a per device basis, and it lacks the dynamics of the network traffic changes on a real-time basis, it falls short of the needs of the user **120**, and to truly maximize the network performance to the peak level.

[0082] The inventive ICMM **23**, or icXengine **23**, is a scalable design that is actually replicated and enforced across all the products in the customer network through software push through and be controlled by a centralized cloud based system **175**.

[0083] FIG. **5**, illustrates how the IOT (Internet of Things) **500**, has a global impact.

[0084] FIG. **6**, illustrates how Internet of Things (IOT) **600**, continues to speed up over time, complexity of content, and type of use.

[0085] The inventive intelligent control and management matrix (ICMM) **23**, or icXengine **23**, is designed to help resolve a consistent issue seen in packet transmission technology, such as, for example, Ethernet technology, which is called contention. In one aspect the inventive ICMM **23**, monitors **140**, polls **160**, and acts based on traffic flow information **180**, to reduce contention, and to allow more data **125**, voice **130**, video **135**, etc. to pass through the Ethernet system **123**.

[0086] The inventive ICMM **23**, or icXengine **23**, uses various IEEE features for traffic management, such as, for example, Quality-of-Service (QoS) **60**, Traffic Specification (TSPEC) **70**, Load Balancing **80**, Rate Limiting **90**, and others **100**, such as, for example, sFlow **100**, Bandwidth Shaping **100**, to name a few, to be able to avoid as many collisions, thus enabling more packets through the LAN **123**, and on to their destination. This is accomplished by using the inventive software to monitor, manage, and dynamically change traffic flows which reduces contention. The reduction of contention results in fewer collisions and an increase in usable bandwidth. Switched Ethernet can also be used to solve some of these issues, however the explosion of mobility and Wi-Fi combined with the Internet of Things (IOT), increases the use of shared mediums carrier sense multiple access (CSMA), thus further compounding the issue. The inventive ICMM **123**, also helps deal with these issues by centrally controlling data flows to reduce end point/user contention more quickly.

[0087] Another benefit of the inventive ICMM **23**, or icXengine **23**, is a simplification of management. As ICMM **23**, utilizes the various features to ensure proper data flows, it alleviates the need for IT Admin to measure each advanced feature individually to decided how much of each features is needed to run an efficient LAN **123**. Moreover, it more efficiently calculates, decides and changes parameters quickly to ensure dynamic adjustments, both big and small, to be made faster and more proactively.

[0088] The inventive ICMM **23**, or icXengine **23**, allows one to increase efficiency so as to allow more data traffic **125**, **128**, **130**, **135**, **138**, users **120**, and management **110**, possible over the same networking ecosystem **123**. This is very important in the age of the Internet of Things (IOT). IOT is the explosion of connectedness around the globe that continues to increase the volumes of data **125**, **128**, **130**, **135**, **138**, users **120**, devices **120**, and interactions that happen over an IP Data Network **123**. This Hyper-connectedness isn't just about communication between people **120**, but Machine-to-Machine communication **120**, is expected to outpace that of people by nearly 4 or 5 to 1. Therefore, the more efficient an IP Data infrastructure **123**, the more communication it can allow to pass through it's network **123**.

[0089] The inventive ICMM **23**, or icXengine **23**, is a holistic and heuristic engine **23**, that polls, thinks, and then utilizes various methods to accomplish its optimization objectives. It's central objective it not to drop packets, so to that end, the application leverages already existing product features including but not limited to Quality-of-service (QoS) **60**, Traffic Specification (TSPEC) **70**, Load Balancing **80**, and Rate Limiting **90**, sFlow **100**, among others to balance flows of data. This is also unique because used individually, these features attempt to allow better performance, but they do so based on IT administration established priority profiles, while the inventive ICMM **23**, or icXengine **23**, sees that ALL IP traffic **125**, **128**, **130**, **135**, **138**, must get through the system **123**, and balances transmissions vis-a-vis the other IP packets and against the usable bandwidth resources. It has capabilities to dynamically adjust the game plan on the go based on an ever changing nature of the network **123**, at any given time of the day.

[0090] The inventive ICMM **23**, or icXengine **23**, is applicable on and for any IP data network ecosystem **123**. It can exist on any device **120**, that transmits or receives IP information and has to process that information using a set of processing tools such as Quality-of-service (QoS) **60**, Load Balancing **80**, to name a few.

[0091] The invention **23**, allows the user **120**, to reduce their cost per device **120**, on their network **123**. The ability to handle more devices **120**, per access point **110**, or switch **110**, enables a better OpEx (Operation Expenses) cost for the user **120**. It also allows for better service and delivery of more complex applications, such as, for example, data **125**, mission critical data **128**, voice over IP **130**, streaming media **135**, gaming sessions **138**, to name a few.

[0092] The continued explosive growth of IOT **500**, **600**, depends on the transmission, processing and reception of content. Much like a freeway that becomes too clogged with car traffic, so can an IP data network suffer from too much content, devices, users **125**, **128**, **130**, **135**, **138**, **120**, trying to communicate at the same time. If information can't traverse the network **123**, its value comes into question and has the potential to slow growth, revenue expansion, development, and can impact global economies.

[0093] The inventive ICMM **23**, or icXengine **123**, provides a method to alleviate traffic through the use of various tools (not just one method) to automate traffic, route traffic, speed/slow traffic, redirect traffic to different locations, and many other actively dynamic and intelligent traffic cop methods.

[0094] The inventive ICMM **23**, or icXengine **23**, is different because:

[0095] 1. The invention **123**, starts with the assumption that contention can/should be eliminated;

[0096] 2. The invention **123**, uses existing features **60**, **70**, **80**, **90**, **100**, as part of the policy matrix as opposed to one or two;

[0097] 3. The invention **123**, focuses on all aspects of the communication traffic from Ingress/Egress, WAN/LAN, Analytics, Traffic heuristics, Feature Handling, to name a few;

[0098] 4. The invention **123**, works dynamically with the "current" network contention situation and perform a 'just-in-time' methodology of traffic shaping and prioritization.

[0099] This inventive ICMM **23**, or icXengine **23**, considers as many variables as possible to arrive at an optimal performance level for the IP Data Network **123**. In addition, this invention reduces network contention and removes parts that would lessen the effect of the overall invention. Leaving parts or features out may result in omitting variables that might not impact just one network but could have a meaningful impact on other network designs.

[0100] It should be noted that with this invention pieces can be combined as long as the IP Data Traffic and IEEE standards can be combined, which means that the main parts of IP transmissions from ingress of packets, destination determination and routing to the egress, are standard but this invention can change if those objectives change.

[0101] The inventive ICMM **23**, or icXengine **23**, can be widely used by all points of IP Network interaction. For some applications the ICMM invention **23**, could be integrated into the chip level processing. Integration into open standards would allow third party vendors to utilize the ICMM inventive technology **123**. The more widely used the ICMM invention **123**, the more areas of the Global IP Data ecosystem becomes efficient and that would allow more communication to take place.

[0102] This inventive ICMM **23**, or icXengine **23**, can be used with any Internet Protocol (IP) as part of its communication infrastructure. The ICMM invention **23**, can also be used with any communication protocol in the world, just as the global communication standards continue to shift to TCP/IP leaving behind other standards like Token Ring, ArcNet, Sonet, Fiber Channel, and many others, to name a few.

[0103] The inventive ICMM **23**, or icXengine **23**, used in the present invention, may be implemented using one or more computers **175**, executing software instructions. According to one embodiment of the present invention, the computer **175**, having a screen **175**, may communicate with a server **175**, and client computer systems **175**, that transmits and receives data over a computer network **123**, or a fiber or copper-based telecommunications network **123**. The steps of accessing, monitoring, and manipulating the flow of data, as well as other aspects of the present invention are implemented by central processing units (CPU) **175**, in the server **175**, and client computers **175**, executing sequences of instructions stored in a memory **175**. The memory **175**, may be a random access memory (RAM), read-only memory (ROM), a persistent store, such as a mass storage device, or any combination of these devices. Execution of the sequences of instructions causes the CPU **175**, to perform steps according to embodiments of the present invention **123**.

[0104] The instructions may be loaded into the memory **175**, of the server **175**, or client computers **175**, from a storage device **175**, or from one or more other computer systems **175**, over a network connection **123**. For example, a client computer **175**, may transmit a sequence of instructions to the server computer **175**, in response to a message transmitted to the client over a network **123**, by the server **175**. As the server **175**, receives the instructions over the network connection **123**, it stores the instructions in memory. The server **175**, may store the instructions for later execution, or it may execute the instructions as they arrive over the network connection **123**. In some cases, the CPU may directly support the downloaded instructions. In other cases, the instructions may not be directly executable by the CPU **175**, and may instead be executed by an interpreter that interprets the instructions. In other embodiments, hardwired circuitry may be used in place of, or in combination with, software instructions to implement the present invention **123**. Thus tools used in the present invention are not limited to any specific combination of hardware circuitry and software, nor to any particular source for the instructions executed by the server or client computers. In some instances, the client and server functionality may be implemented on a single computer platform or an embedded firmware hardware device **175**.

[0105] Thus, the present invention is not limited to the embodiments described herein and the constituent elements of the invention can be modified in various manners without departing from the spirit and scope of the invention. Various aspects of the invention can also be extracted from any appropriate combination of a plurality of constituent elements disclosed in the embodiments. Some constituent elements may be deleted in all of the constituent elements disclosed in the embodiments. The constituent elements described in different embodiments may be combined arbitrarily.

[0106] Still further, while certain embodiments of the inventions have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel methods and systems described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the methods and systems described herein may be made without departing from the spirit of the inventions.

[0107] It should be further understood that throughout the specification and claims several terms have been used and they take the meanings explicitly associated herein, unless the context clearly dictates otherwise. For example, the phrase “in one embodiment” as used herein does not necessarily refer to the same embodiment, though it may. Additionally, the phrase “in another embodiment” as used herein does not necessarily refer to a different embodiment, although it may. Thus, various embodiments of the invention may be readily combined, without departing from the scope or spirit of the invention.

[0108] While the present invention has been particularly described in conjunction with a specific preferred embodiment, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art in light of the foregoing description. It is therefore contemplated that the appended claims will embrace any such alternatives, modifications and variations as falling within the true scope and spirit of the present invention.

What is claimed is:

1. A method for controlling data packet transmission in a data network of a communication system comprising:

defining a first level of packet transmission rate, which first level establishes a queue system for lower priority data packets based on one of at least one first criteria calculations, and at least one second criteria calculations;

defining a second level of packet transmission rate, which second level diverts lower priority data packets into said queue system based on type of data packet;

defining a third level of packet transmission rate, which third level diverts lower priority data packets into said queue system based on protocol precedence of data packet;

transmitting data packets over a data network;

determining rate of data packet transmission over said data network;

determining type of data packet transmitted over said data network;

responsive to a packet transmission rate exceeding said first level, establishing a queue system for lower priority data packets based on said one of at least one first criteria calculations, and at least one second criteria calculations;

responsive to a packet transmission rate exceeding said second level, diverting lower priority data packets into said queue system based on type of data packet; and responsive to a packet transmission rate exceeding said third level, diverting lower priority data packets into said queue system based on protocol precedence of data packet.

2. The method of claim **1**, wherein said at least one first criteria calculations are based on at least one sample size.

3. The method of claim **1**, wherein said at least one second criteria calculations are based on at least one sample interval.

4. The method of claim **1**, wherein said at least one first criteria calculations are based on at least one sample size, and wherein said at least one second criteria calculations are based on at least one sample interval.

5. The method of claim **1**, wherein said data packets diverted into said queue system are removed from said queue system as packet transmission rate falls below said third level.

6. The method of claim **1**, wherein said data packets diverted into said queue system are removed from said queue system as packet transmission rate falls below said third level and said second level.

7. The method of claim **1**, wherein said determination of rate of data packet transmission over said data network and determination of type of data packet transmitted over said data network are performed by polling said data packets being transmitted over said data network at a rate using at least one third criteria selected from a group consisting of quality-of-service policy, traffic specification policy, load balancing policy, rate limiting policy, other policy, and combinations thereof.

8. The method of claim **1**, wherein said data packets are selected from a group consisting of web browsing data packet, email data packet, social media data packet, peer-to-peer data packet, peer-to-multi-peer data packet, mission critical data packet, voice data packet, multi-media streaming data packet, video data packet, gaming application data packet, and combinations thereof.

9. The method of claim **1**, wherein said defining of said first level of packet transmission rate, said defining of said second level of packet transmission rate, said defining of said third level of packet transmission rate is performed by an operator.

10. The method of claim **1**, wherein said defining of said first level of packet transmission rate, said defining of said second level of packet transmission rate, said defining of said third level of packet transmission rate is done based on a percentage bandwidth.

11. A system for controlling data packet transmission in a data network of a communication system comprising:

defining a first level of packet transmission rate, which first level establishes a queue system for lower priority data packets based on one of at least one first criteria calculations, and at least one second criteria calculations;

defining a second level of packet transmission rate, which second level diverts lower priority data packets into said queue system based on type of data packet;

defining a third level of packet transmission rate, which third level diverts lower priority data packets into said queue system based on protocol precedence of data packet;

transmitting data packets over a data network;

determining rate of data packet transmission over said data network;

determining type of data packet transmitted over said data network;

responsive to a packet transmission rate exceeding said first level, establishing a queue system for lower priority data packets based on said one of at least one first criteria calculations, and at least one second criteria calculations;

responsive to a packet transmission rate exceeding said second level, diverting lower priority data packets into said queue system based on type of data packet; and

responsive to a packet transmission rate exceeding said third level, diverting lower priority data packets into said queue system based on protocol precedence of data packet.

12. The system of claim **11**, wherein said at least one first criteria calculations are based on at least one sample size.

13. The system of claim **11**, wherein said at least one second criteria calculations are based on at least one sample interval.

14. The system of claim **11**, wherein said at least one first criteria calculations are based on at least one sample size, and wherein said at least one second criteria calculations are based on at least one sample interval.

15. The system of claim **11**, wherein said data packets diverted into said queue system are removed from said queue system as packet transmission rate falls below said third level.

16. The system of claim **11**, wherein said data packets diverted into said queue system are removed from said queue system as packet transmission rate falls below said third level and said second level.

17. The system of claim **11**, wherein said determination of rate of data packet transmission over said data network and determination of type of data packet transmitted over said data network are performed by polling said data packets being transmitted over said data network at a rate using at least one third criteria selected from a group consisting of quality-of-service policy, traffic specification policy, load balancing policy, rate limiting policy, other policy, and combinations thereof.

18. The system of claim **11**, wherein said data packets are selected from a group consisting of web browsing data packet, email data packet, social media data packet, peer-to-peer data packet, peer-to-multi-peer data packet, mission critical data packet, voice data packet, multi-media streaming data packet, video data packet, gaming application data packet, and combinations thereof.

19. A non-transitory computer-readable storage medium with an executable program application stored thereon, the program application configured for controlling data packet transmission in a data network, the program application configured to be accessible over a communications network, wherein the program application instructs a computer processor to perform the following steps of:

defining a first level of packet transmission rate, which first level establishes a queue system for lower priority data packets based on one of at least one first criteria calculations, and at least one second criteria calculations;

defining a second level of packet transmission rate, which second level diverts lower priority data packets into said queue system based on type of data packet;

defining a third level of packet transmission rate, which third level diverts lower priority data packets into said queue system based on protocol precedence of data packet;

transmitting data packets over a data network;

determining rate of data packet transmission over said data network;

determining type of data packet transmitted over said data network;

responsive to a packet transmission rate exceeding said first level, establishing a queue system for lower priority data packets based on said one of at least one first criteria calculations, and at least one second criteria calculations;

responsive to a packet transmission rate exceeding said second level, diverting lower priority data packets into said queue system based on type of data packet; and

responsive to a packet transmission rate exceeding said third level, diverting lower priority data packets into said queue system based on protocol precedence of data packet.

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