



# THE MAZED PATENT PORTFOLIO

## FIBER-TO-THE-PREMISES (FTTP) AND INTELLIGENT SUBSCRIBER UNIT TECHNOLOGIES, INTEGRATING INTERNET OF THINGS (IoT)

### *A Patent Portfolio Acquisition Opportunity*

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# Fiber-to-the-Premises and Intelligent Subscriber Unit Technologies, Integrating Internet of Things (IoT)

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### EXECUTIVE SUMMARY

**IP**investments Group has been retained by the sole inventor, Mo Mazed to broker the sale of pioneering patented technologies (the "Portfolio") related to Fiber-To-The-Premises (FTTP) access network(s).

#### **The Portfolio Enables Pioneering Patented Technologies such as, but not limited to:**

1. A Fiber-To-The-Premises (FTTP) access network(s) based optical systems for providing enormous bandwidth (e.g., gigabits or more bandwidth per seconds) at a premise (e.g., a home or business) at a significantly lower cost; and
2. An intelligent subscriber unit for machine to machine (M2M) or Internet of Things (IoT) connectivity at the premise.

At this time, the Portfolio is being offered to select companies, as well as patent acquisition and financing organizations, who participate in the relevant markets and industries. The table below summarizes the Portfolio.

PATENT No.	TITLE	APP. No.	FILING DATE	ISSUE DATE
8,548,334	Dynamic intelligent bidirectional optical access communication system with object/intelligent appliance-to-object/intelligent appliance interaction	12/931,384	01/31/11	10/01/13
8,073,331	Dynamic Intelligent Bidirectional Optical and Wireless Access Communication System	11/952,001	12/06/07	12/06/11
N/A	Dynamic intelligent bidirectional optical access communication system with object/intelligent appliance-to-object/intelligent appliance interaction	14/014,239	08/29/13	TBD
N/A	Portable Internet Appliance	12/238,286	09/25/08	TBD

Note: The issued U.S. patents are provided in the appendix of this document. All pending applications and file wrappers are available upon request.

### PATENTED TECHNOLOGY HIGHLIGHTS

#### **Some Key Benefits of the Portfolio:**

- ♦ With (a) a longer-reach FTTP access network(s) between the premise and the node; and (b) colorless color wavelength scheme for enabling a universal optical subsystem within the subscriber unit at all premises; both capital and operational costs related to FTTP access network(s) can be significantly reduced, in order to provide gigabits or more bandwidth per second at the premise.

# Fiber-to-the-Premises and Intelligent Subscriber Unit Technologies, Integrating Internet of Things (IoT)

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- ◆ Furthermore, the subscriber unit at the premise is intelligent, which can enable machine to machine (M2M) or Internet of Things (IoT) connectivity.

### **Example Inventive Elements of The Portfolio are:**

- ◆ To reduce the Rayleigh backscattering (RBS) effect on the transmission of optical signals - thereby enabling a longer-reach (greater than ~ 60 Km) FTTP access network(s) between the premise and a node/head-end;
- ◆ To enable a colorless color wavelength scheme at the subscriber unit - thereby enabling a universal optical subsystem within the subscriber unit at all premises;
- ◆ To enable bandwidth on-Demand or service on-Demand (e.g., video on-Demand (VOD) or instant telepresence) to the subscriber unit;
- ◆ To enable dynamic allocation of wavelength(s) to the subscriber unit;
- ◆ To enable dynamic allocation of bandwidth to and from the subscriber unit;
- ◆ To enable dynamic protection of wavelength to and from the subscriber unit;
- ◆ To enable machine to machine (M2M) or Internet of Things (IoT) connectivity with the subscriber unit - thereby enabling an intelligent subscriber unit (at the premise).

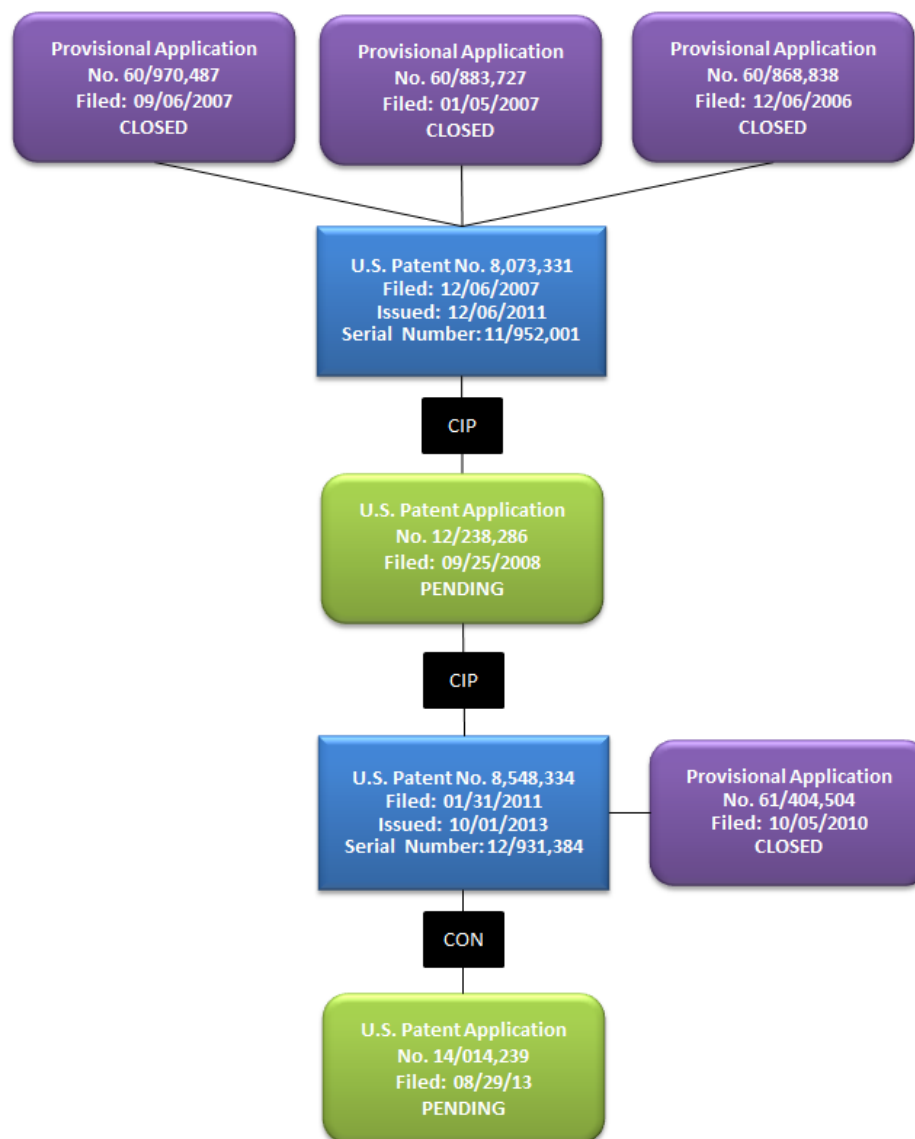
### **FAMILY RELATIONSHIPS**

The family relationships of the assets in the portfolio are illustrated in the flow chart provided on the following page.

# Fiber-to-the-Premises and Intelligent Subscriber Unit Technologies, Integrating Internet of Things (IoT)

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### OVERVIEW OF THE RELEVANT TECHNOLOGY AND APPLICATIONS

Our ability to access any content, any time and from any place is critical. A converged and pervasive always-on internet will be the global network of human connections, ideas, collaboration, commerce, and distributed intelligence. To meet ever increasing bandwidth demand, Fiber-to-the-Premises (FTTP) access network(s) is the only secure, and reliable technology of the future.

More than 120 countries worldwide have developed broadband policies, recognizing that such

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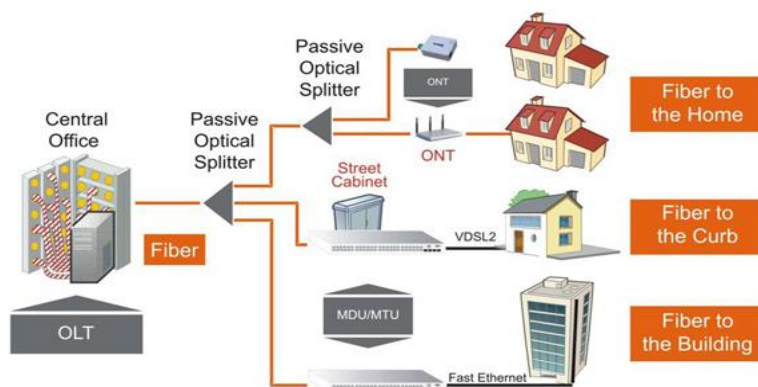
Fiber-to-the-Premises (FTTP) access network(s) is critical for the development of economy, healthcare, education, and e-government. All these needs point to a Fiber-to-the-Premises (FTTP) access network(s) as the best future-proof solution.

Major players in the fiber optics market include **Verizon** (Quantum FiOS®/FiOS®), **AT&T** (U-verse®), **Google (Gigabits to Home)**, and **Century Link**, among many other technology providers and local service providers (e.g., Cincinnati Bell, LUS Fiber, EPB Fiber Optics, etc.).

FTTP access network(s) is a technology for providing internet access by running fiber optic cables directly from an Internet Service Provider (ISP) to a home or business and it provides **enormous bandwidth** than the coaxial cable internet access, and generally needs to be serviced less. It is also considered the best “future proof” Internet access technology, since there is no foreseeable technology to match its enormous bandwidth capacity.

Fiber optic cables are made of long strands of glass covered by protective plastic buffers, and signals are sent via pulses of light signal rather than electricity. Data over this medium can be sent quickly with little resistance and deterioration. Though the signals still have to be converted into electricity to use at the premise, in FTTP access network(s), the fiber optic cable runs directly to the subscriber's home or building. There it connects into a Network Interface Device (NID), which converts the light (wavelength) signals into electrical signals.

As shown in the Figure below, FTTP access network(s) can refer to either Fiber-To-The-Home (FTTH) or Fiber-To-The-Building (FTTB). FTTH is a system in which the fiber goes directly into individual homes, while FTTB is a system where the fiber goes to the building and from there splits off to multiple subscribers within the building via non-optical connections – like copper cables or a wireless connection. A similar type of connection is Fiber-To-The-Curb (FTTC), where a fiber optic cable terminates at a curb side, thereby connecting to the subscribers with copper cables. All of the above technologies are generally referred to collectively as FTTP access network(s) and can be implemented using the patented technology offered in the Portfolio.



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### ADVANTAGES OF FIBER OPTICS:

- ◆ **Bandwidth Capacity (Speed), Security and Reliability:** The main advantages of FTTP access network(s) are the bandwidth capacity (speed), security, and reliability in transmitting signals. This means that subscribers can both upload and download files very quickly at a symmetrical bandwidth capacity (speed), and also have high quality streaming media. This holds true even over a longer distance; however a signal sent over copper would deteriorate or die out quickly after a short distance.
- ◆ **Long-Term Use:** FTTP access network(s) is expected to be usable as-is for a very long time and it can transmit the full optical spectrum of light, there is no foreseeable technology to match its enormous bandwidth capacity. The huge amount of data that can be sent on this type of network also gives technology designers more freedom, without worrying about bandwidth limitation.
- ◆ **Long-Term Durability:** Fiber optic cable is generally more durable than copper, since the materials it's made out of are less susceptible to weather damage. This means that the network doesn't need to be serviced as often, which is more convenient for the ISP and subscribers. Additionally, most fiber optic cables can be expected to perform reliably for at least 40 years, whereas copper cabling may have to be updated as often as every 5 years to remain useful.
- ◆ **Remote Monitoring and Control:** The FTTP access network(s) is easier to monitor than coaxial cables and its problems can be identified remotely at the ISP, with some diagnostics devices able to detect where a problem within about 5 feet (1.5 meters). This makes it easier for technicians to repair any faults quickly.
- ◆ **Flexible Services:** The FTTP access network(s) can be configured with ready-to-use for telephony, TV, video on-Demand (VOD) and internet services. If a subscriber does decide to only start out with just one service, the ISP can activate any additional service(s) remotely as they are needed.

### THE PATENT PORTFOLIO

The Portfolio's innovative FTTP access network(s)'s technology utilizes optical components:

- ◆ a quantum dot based semiconductor optical amplifier;
- ◆ a phase modulator; and
- ◆ an intensity modulator.

The Portfolio's innovative FTTP access network(s)'s technology significantly reduces the Rayleigh backscattering effect (RBS) on the transmission of optical signals. Reduced Rayleigh backscattering effect (RBS) enabled by the patented technologies provides a longer-reach (greater than ~ 60 Km) FTTP access network(s) between the subscriber unit and the node/head

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end, than currently deployed FTTP access network(s).

Thus, longer-reach access eliminates both capital and operational costs, related to a vast array of middle equipment like routers and switches, which would otherwise be deployed between the subscriber unit and the node/head end, in order to provide gigabit bandwidth or more bandwidth to the premise.

Additionally, the patented technologies can enable:

- ◆ a colorless color wavelength scheme at the subscriber unit - thereby enabling a universal optical subsystem within the subscriber unit at all premises;
- ◆ bandwidth on-Demand or service on-Demand (e.g., video on-Demand (VOD) or instant telepresence) to the subscriber unit;
- ◆ dynamic allocation of wavelength(s) to the subscriber unit;
- ◆ dynamic allocation of bandwidth to and from the subscriber unit;
- ◆ dynamic protection of wavelength to and from the subscriber unit;
- ◆ machine to machine (M2M) or Internet of Things (IoT) connectivity with the subscriber unit - thereby enabling an intelligent subscriber unit (at the premise).

There are a myriad of innovative features and techniques disclosed in the Portfolio, in particular, demonstrate the pioneering innovative elements of the patented technology:

1. Fiber-optic networks have been used for long distance telecom networks or large enterprise applications. But now, the Portfolio extends the high bandwidth capacity, (speed), security, and reliability of the fiber-optic networks right to subscribers' homes and businesses at a significantly lower cost.
2. The patented Fiber-To-The-Premises (FTTP) access network(s) based optical system provides for various services (e.g., telephony, TV, video on-Demand (VOD) and internet) at the subscriber unit. Various services may be implemented by utilizing dedicated wavelengths for each service.
3. The patented optical system utilizes optical components, such as a quantum dot based semiconductor optical amplifier, a phase modulator, and an intensity modulator to provide upstream signals.
4. The upstream optical signals can be looped back through a quantum dot enabled semiconductor optical amplifier, a phase modulator and an intensity modulator.
5. Then both phase and intensity modulated optical signals are transmitted through a variable optical intensity attenuator.



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6. Use of a quantum dot based semiconductor optical amplifier, a phase modulator, and an intensity modulator in a particular manner, reduces the Rayleigh backscattering effect (RBS) on the transmission of optical signals thus - enabling a longer-reach (greater than ~ 60 Km) simplified FTTP access network(s) topology, by eliminating a vast array of middle equipment, such as routers and switches.
7. Furthermore, FTTP access network(s) with looped back optical signals of a wavelength can provide colorless color at the subscriber unit.
8. FTTP access network(s) is configured with bandwidth on-Demand or service on-Demand (e.g., video on-Demand (VOD) or instant telepresence) to the subscriber unit;
9. FTTP access network(s) is configured with dynamic allocation of wavelength(s) to the subscriber unit;
10. FTTP access network(s) is configured with dynamic allocation of bandwidth to and from the subscriber unit;
11. FTTP access network(s) is configured with dynamic protection of wavelength to and from the subscriber unit;
12. FTTP access network(s) is configured with an array of connectivity options with other devices (e.g., sensors or storage devices) at the premise. For example, an intelligent subscriber system that may be configured for implementing a near-field communication (NFC) enabled intelligent micro-subsystem which may comprise of intelligent appliances with applications such as location based applications and personalized social network that can provide peer-to-peer marketing. This provides implementation of remote surveillance for homes or businesses. Additionally it provides for the hookup of devices that can be remotely controlled.
13. Provisions for secure delivery of a content optical signal to an intended destination by utilizing a low bit-rate destination marker optical signal, which is modulated at a different plane with a different modulation format, in conjunction with a higher-bit rate content optical signal. The low bit-rate destination marker optical signal is extracted and converted from an optical domain to an electrical domain to determine the intended destination, while the content optical signal remains in an optical domain until it is delivered to an intended destination. Thus both routing and security in the delivery of a content optical signal are provided.
14. When light (wavelength) signals reach the subscriber unit, it is then converted into electrical signals at the subscriber unit.



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15. For information that is to be sent from a home or business, the subscriber unit converts electrical signals to light (wavelength) signals for transmission to the node.

### REPRESENTATIVE CLAIMS:

#### **'334 PATENT**

1. An optical system, comprising:
  - (a) A node configured with a remote node comprising: at least one single-mode optical fiber;
  - (b) The node configured with the remote node comprising: at least one optical subsystem, wherein the optical subsystem is selected from the group consisting of: a wavelength division multiplexer, a wavelength division demultiplexer and a cyclic arrayed waveguide grating router;
  - (c) The node further comprising: a first optical subsystem and a second optical subsystem, wherein the first optical subsystem is configured from transmission of more than one gigabit per second of optical signals, wherein the optical signals are selected from one or more wavelengths of a first set of wavelengths, wherein the second optical subsystem is configured for reception of at least one gigabit per second of optical signals, wherein the optical signals are selected from one or more wavelengths of a second set of wavelengths, which are offsets in wavelengths with respect to the first set of wavelengths;
  - (d) the remote node comprising: a subscriber optical subsystem, wherein the subscriber optical subsystem is configured for reception or more than one gigabit per second of optical signals, wherein the optical signals are selected from one or more wavelengths of the first set of wavelengths, wherein the subscriber optical subsystem is further configured for transmission of at least one gigabit per second of optical signals, wherein the optical signals are selected from one or more wavelengths of the second set of wavelengths, which are offset in wavelengths with respect to the first set of wavelengths, wherein the transmission of optical signals is configured by an optical micro-subsystem in a looped arrangement at the subscriber optical subsystem, wherein the optical micro-subsystem is configured for phase modulation, intensity modulation and amplification of optical signals.

#### **'331 PATENT**

1. An optical system for communicating optical signals to and from a subscriber unit, comprises:
  - a first set of selected wavelengths;
  - a second set of selected wavelengths offset from the first set of selected wavelengths;
  - a first subsystem configured to transmit to the subscriber unit, the optical signals of one or more wavelengths from the first set of selected wavelengths over an optical fiber;
  - a second subsystem configured to transmit to the subscriber unit the optical signals of one wavelength selected from the second set of selected wavelengths in statistical time division multiplexing over the optical fiber;
  - a third subsystem at the subscriber unit configured to receive the optical signals of the one or more wavelengths from the first set of selected wavelengths and the optical signals of one wavelength from the second set of selected wavelengths over the optical fiber;
  - a fourth subsystem at a head-end configured to receive looped back optical signals of one wavelength from the second set of selected wavelengths from the subscriber unit to the head-end over the optical fiber;
  - a cyclic arrayed waveguide grating router capable of routing more than one wavelength to the subscriber unit; and
  - a phase modulator, an intensity modulator, an amplifier and a looped back configuration within the subscriber unit.

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US008548334B2

(12) **United States Patent**  
**Mazed**

(10) **Patent No.:** **US 8,548,334 B2**  
(45) **Date of Patent:** **Oct. 1, 2013**

(54) **DYNAMIC INTELLIGENT BIDIRECTIONAL OPTICAL ACCESS COMMUNICATION SYSTEM WITH OBJECT/INTELLIGENT APPLIANCE-TO-OBJECT/INTELLIGENT APPLIANCE INTERACTION**

(76) Inventor: **Mohammad Mazed**, Yorba Linda, CA (US)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **12/931,384**

(22) Filed: **Jan. 31, 2011**

(65) **Prior Publication Data**

US 2011/0158653 A1 Jun. 30, 2011

**Related U.S. Application Data**

(63) Continuation-in-part of application No. 12/238,286, filed on Sep. 25, 2008, which is a continuation-in-part of application No. 11/952,001, filed on Dec. 6, 2007, now Pat. No. 8,073,331.

(60) Provisional application No. 61/404,504, filed on Oct. 5, 2010, provisional application No. 60/970,487, filed on Sep. 6, 2007, provisional application No. 60/883,727, filed on Jan. 5, 2007, provisional application No. 60/868,838, filed on Dec. 6, 2006.

(51) **Int. Cl.**  
**H04B 10/00** (2013.01)  
**H04J 14/02** (2006.01)

(52) **U.S. Cl.**  
USPC ..... **398/140**; 398/72; 398/79; 398/156;  
398/170

(58) **Field of Classification Search**  
USPC ..... 398/140, 72, 79  
See application file for complete search history.

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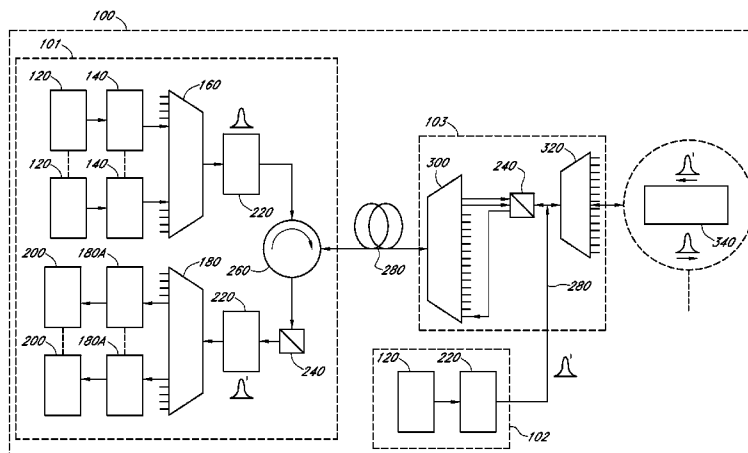
(74) *Attorney, Agent, or Firm* — Leech Tishman Fuscaldo & Lampl, LLP; Ivan Posey, Esq.

(57) **ABSTRACT**

Reduced Rayleigh backscattering effect enables a longer-reach optical access communication network—thus it eliminates significant costs. Furthermore, a wavelength to an intelligent subscriber subsystem can be dynamically varied for bandwidth on-Demand and service on-Demand. A software module renders intelligence (and context awareness) to a subscriber subsystem and an appliance. An object can sense/measure/collect/aggregate/compare/map and connect/couple/interact (via one or more of all electrical/optical/radio/electro-magnetic/sensor/bio-sensor communication network(s) within and/or to and/or from an object) with another object, an intelligent subscriber subsystem and an intelligent appliance utilizing an Internet protocol version 6 (IPv6) and its subsequent versions.

A construction of a near-field communication (NFC) enabled intelligent micro-subsystem and/or intelligent appliance with key applications (e.g., an intelligent, location based and personalized social network and an intelligent, location based and personalized direct and peer-to-peer marketing) are also described.

**25 Claims, 13 Drawing Sheets**



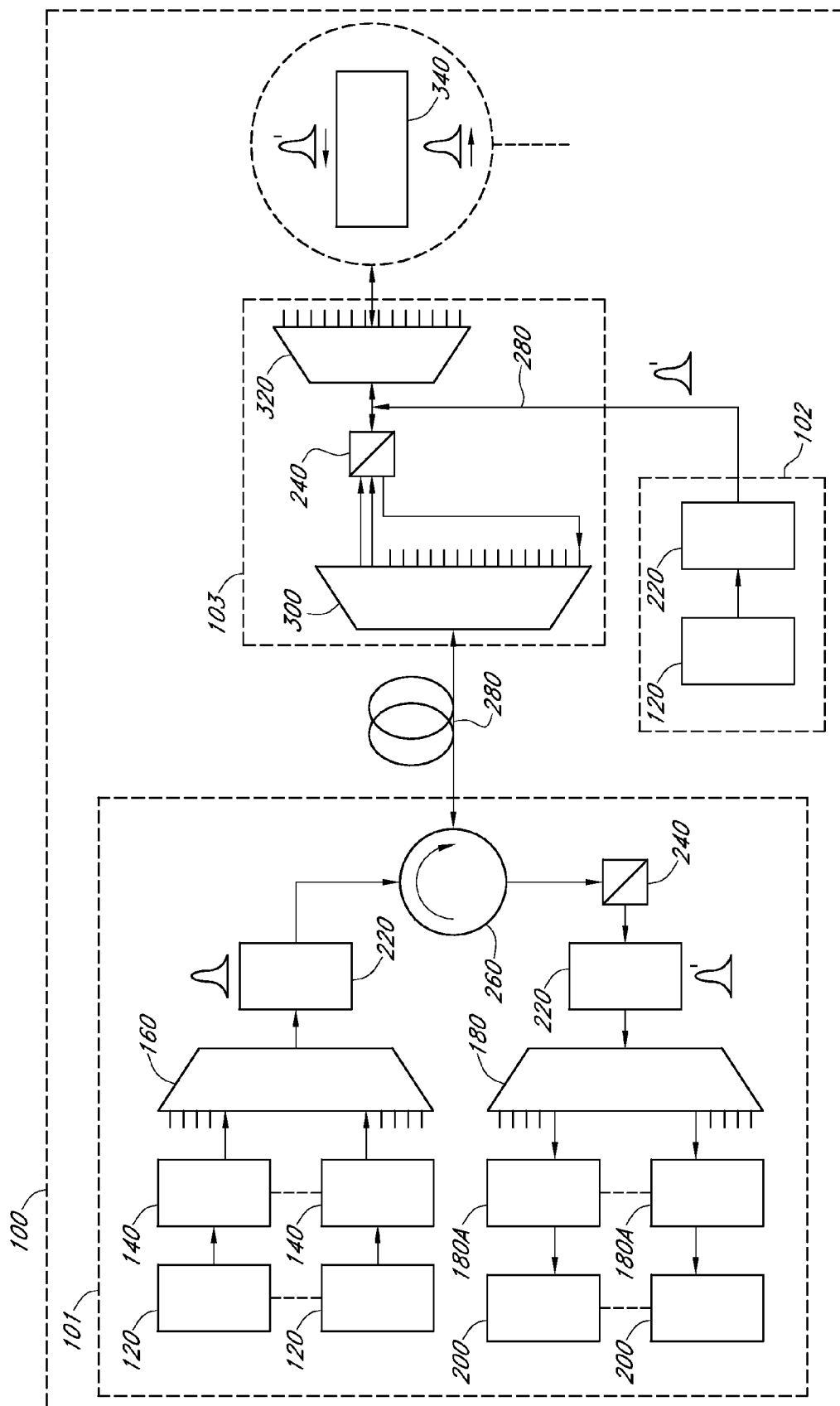


FIG. 1

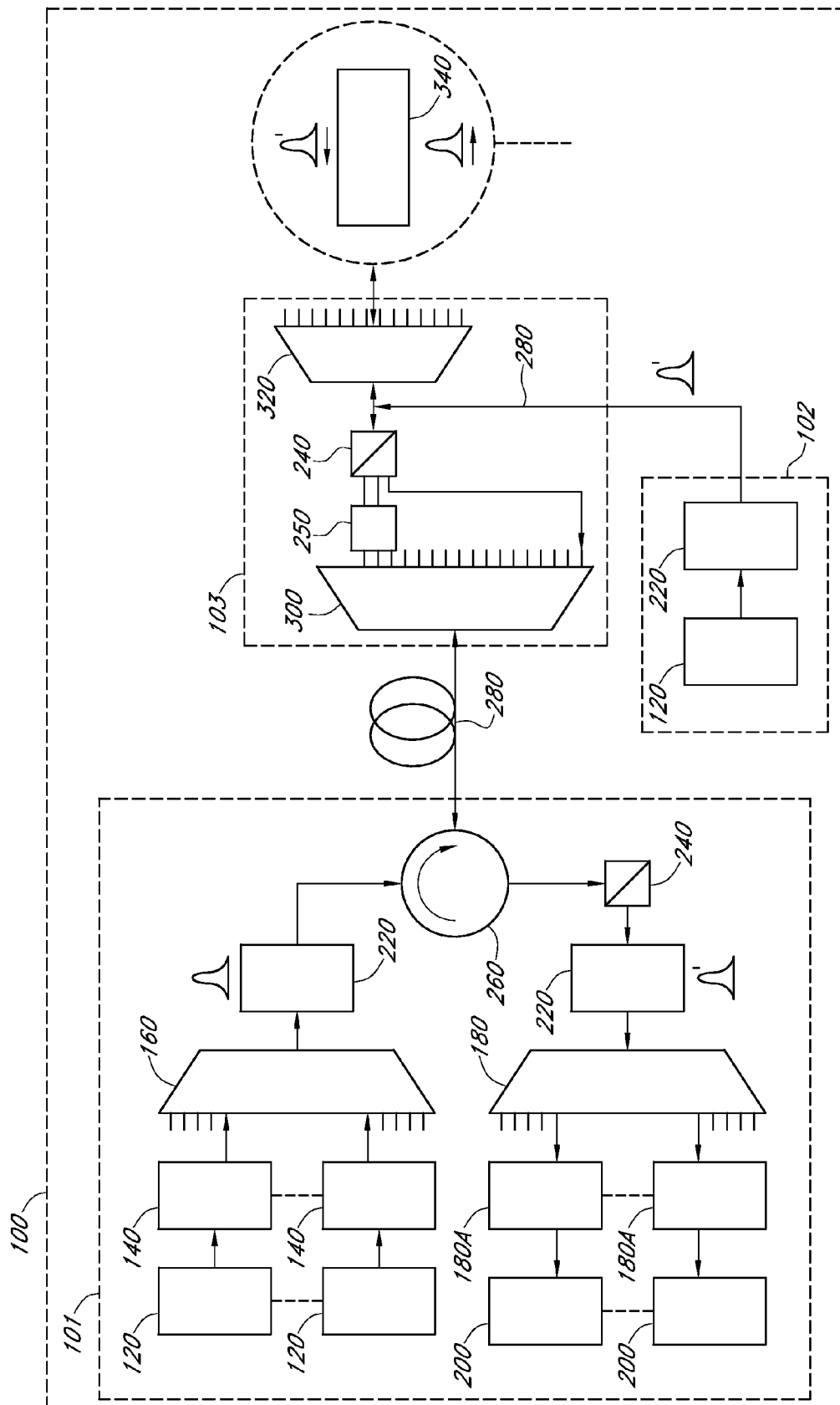


FIG. 2

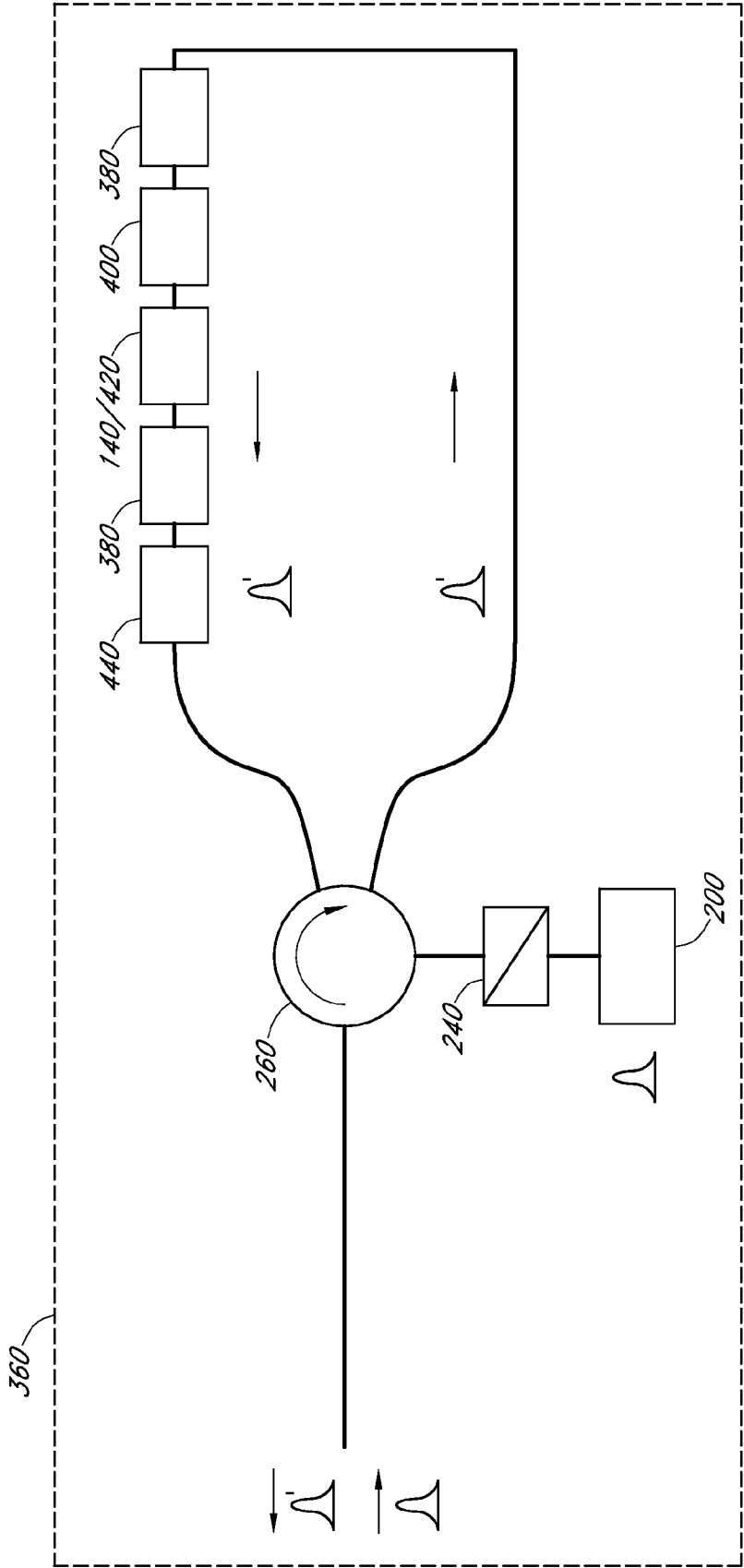


FIG. 3

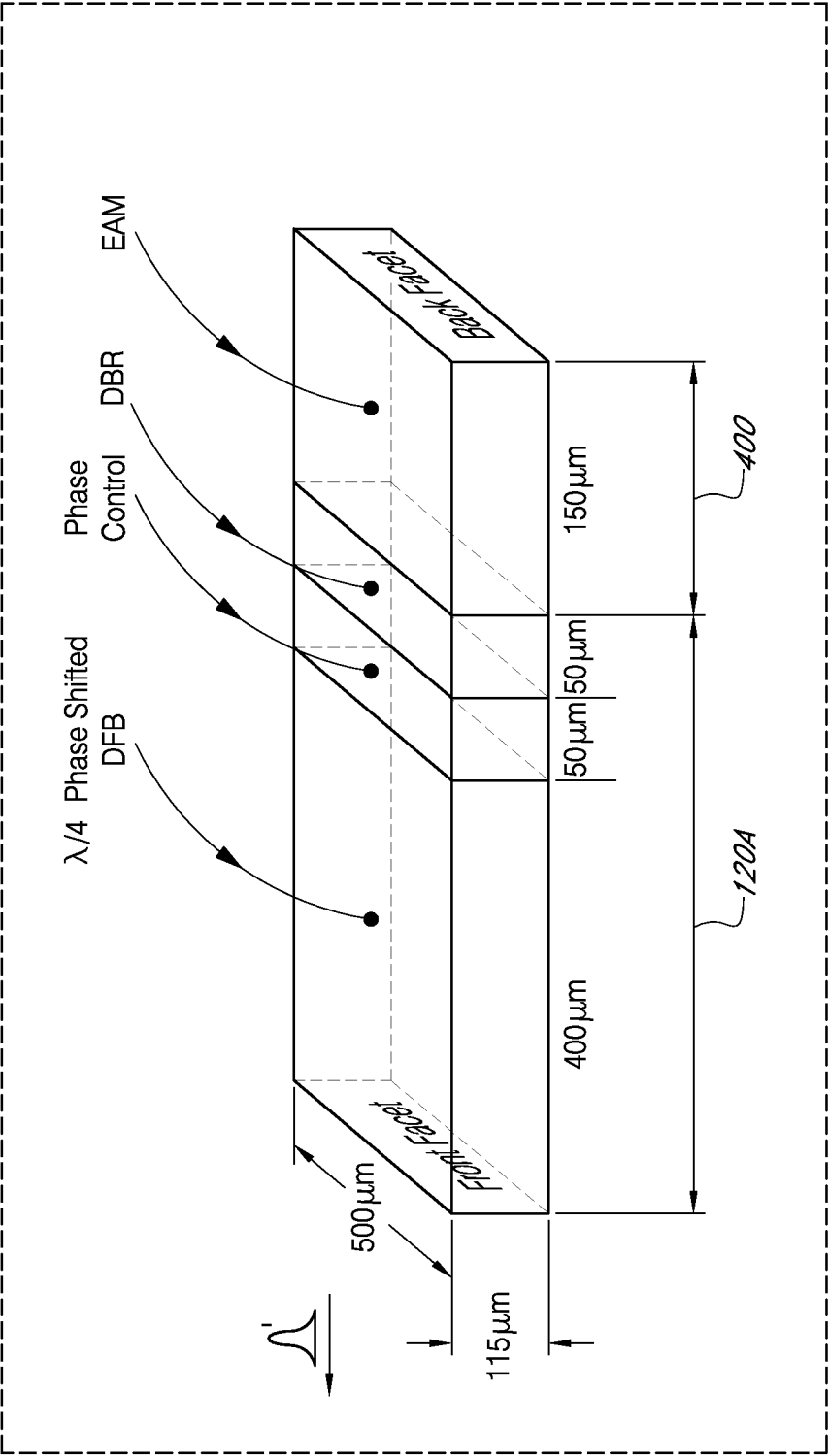


FIG. 3A



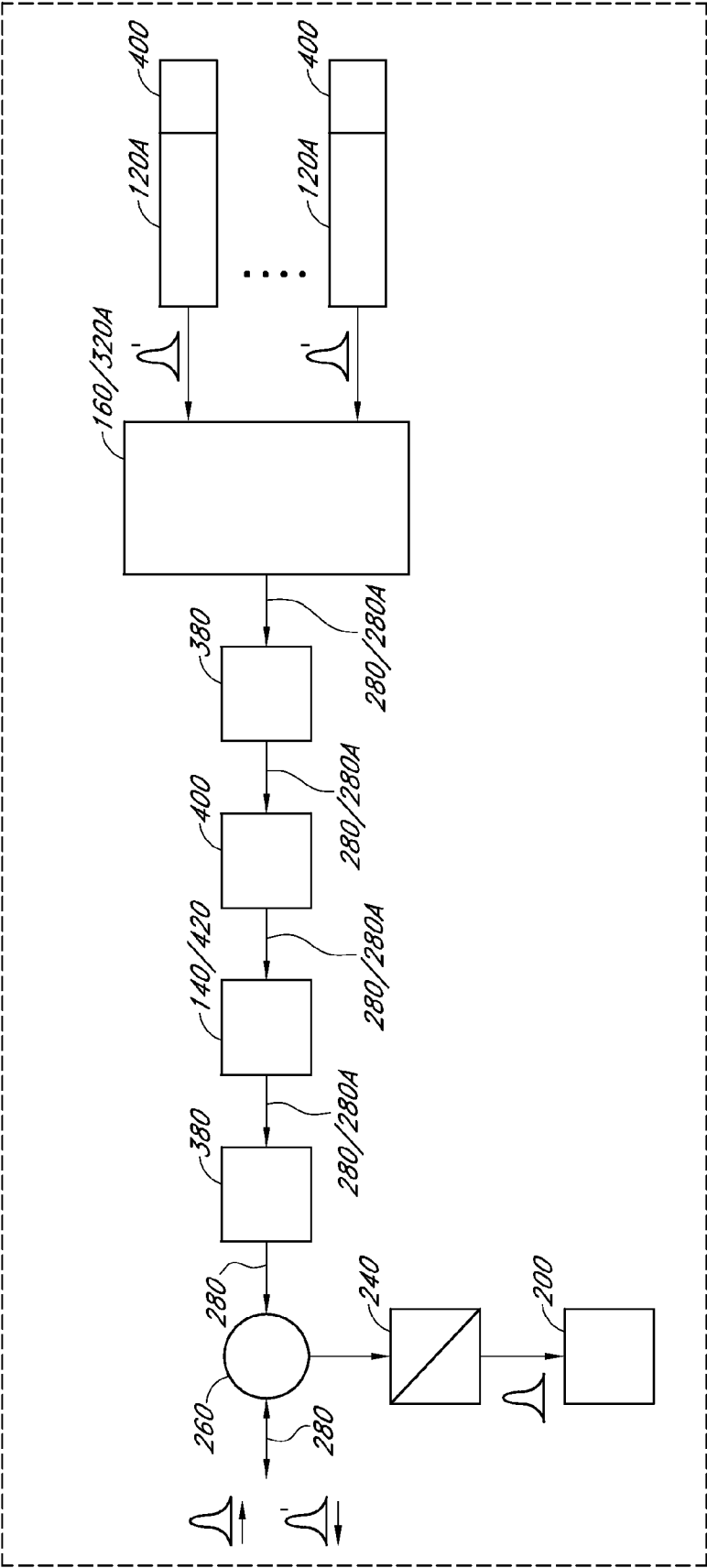


FIG. 3B

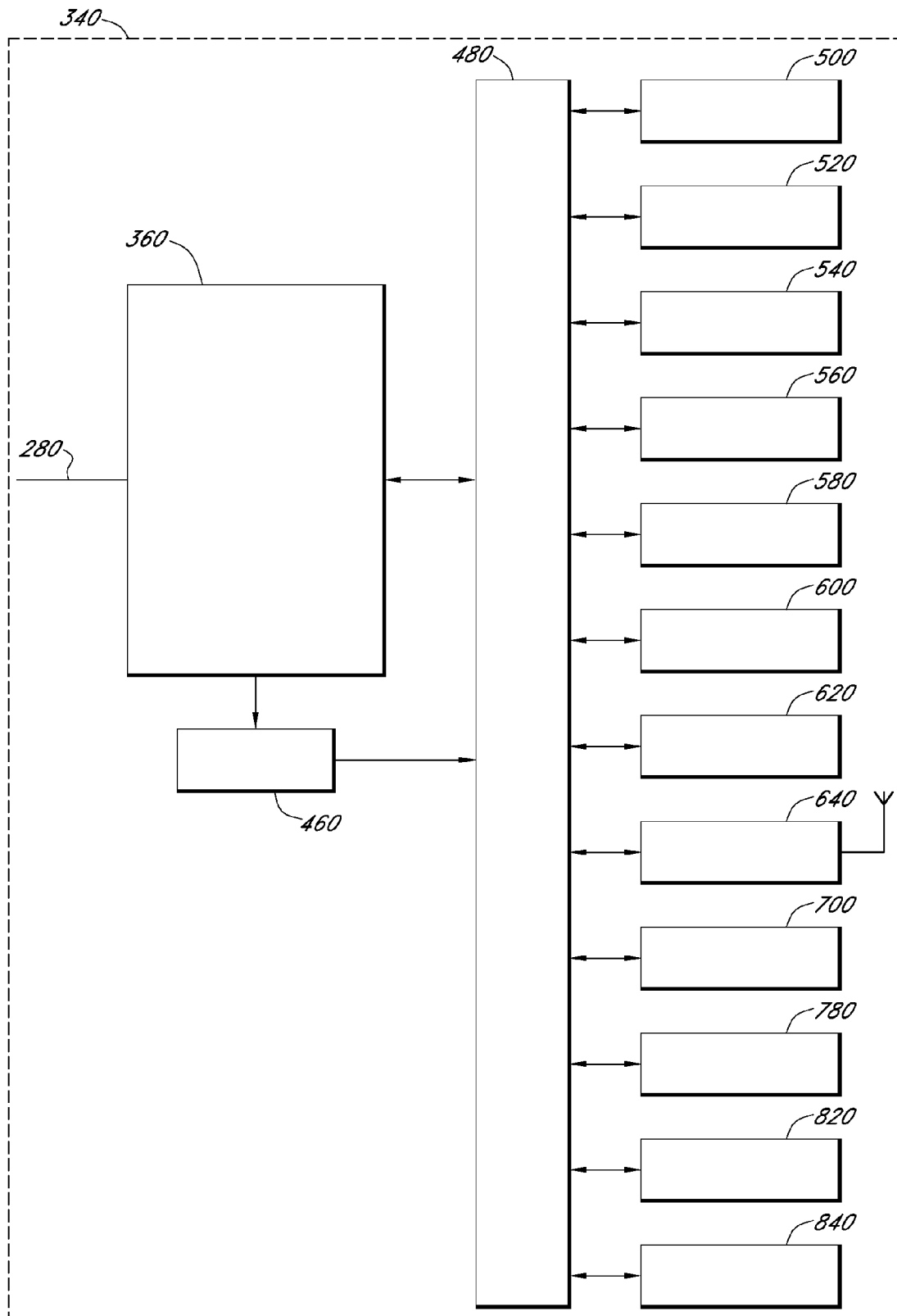


FIG. 4

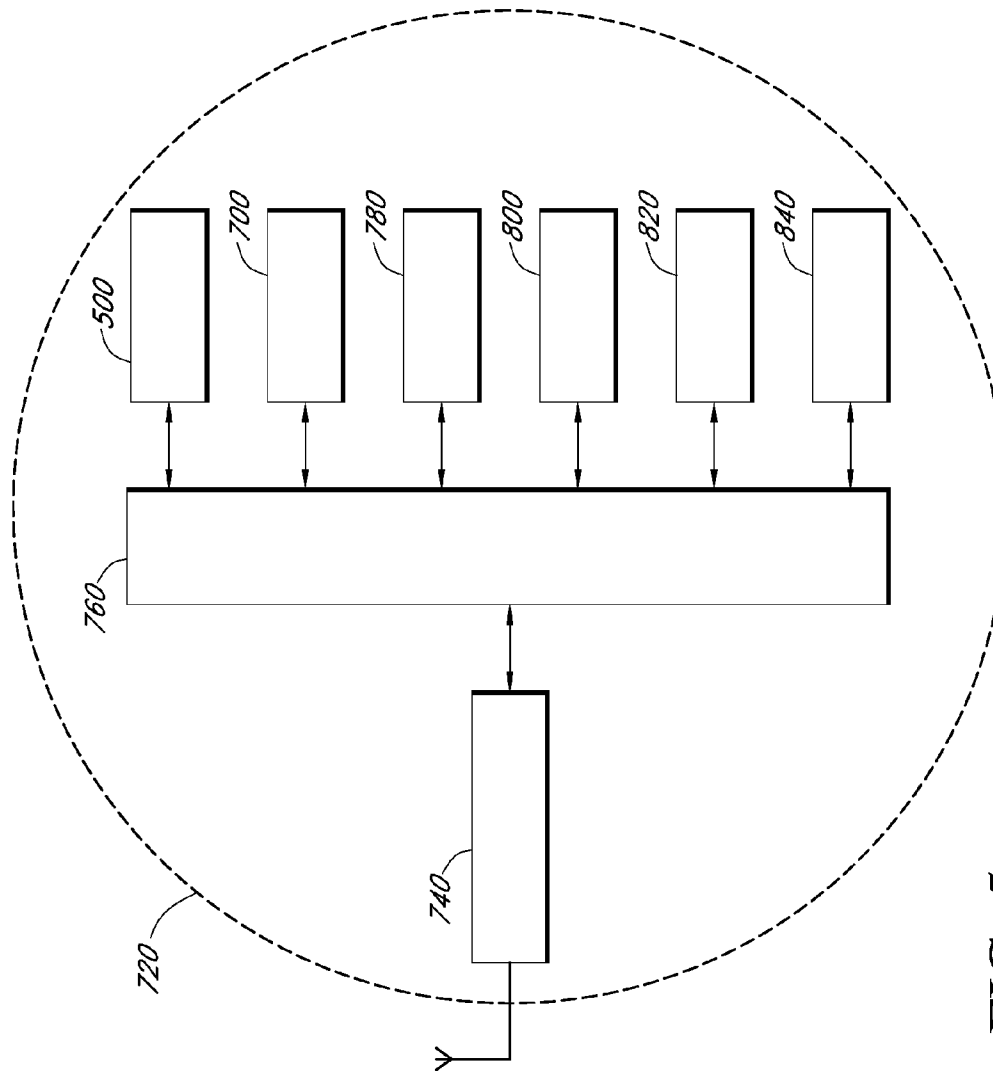


FIG. 5

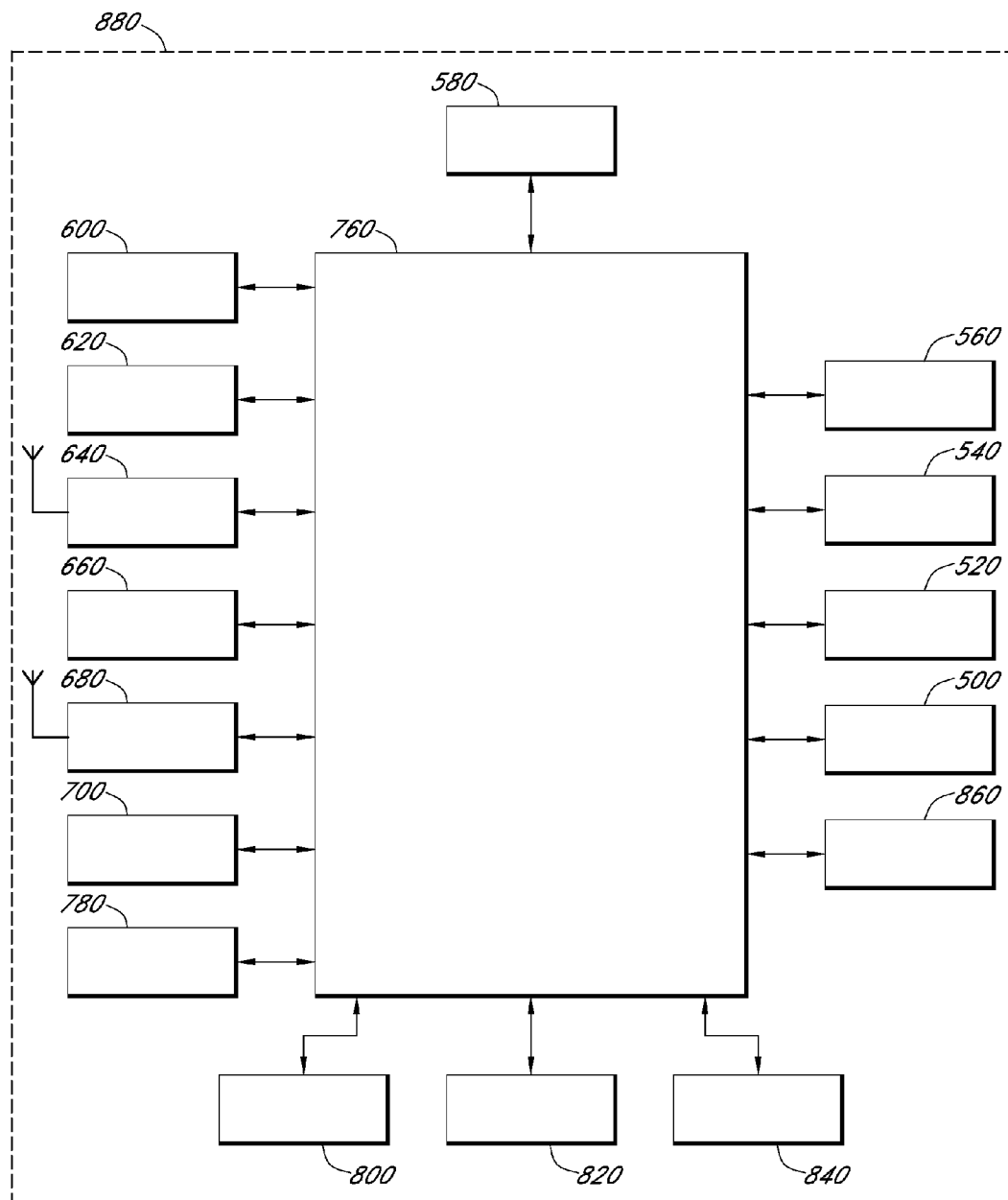


FIG. 6

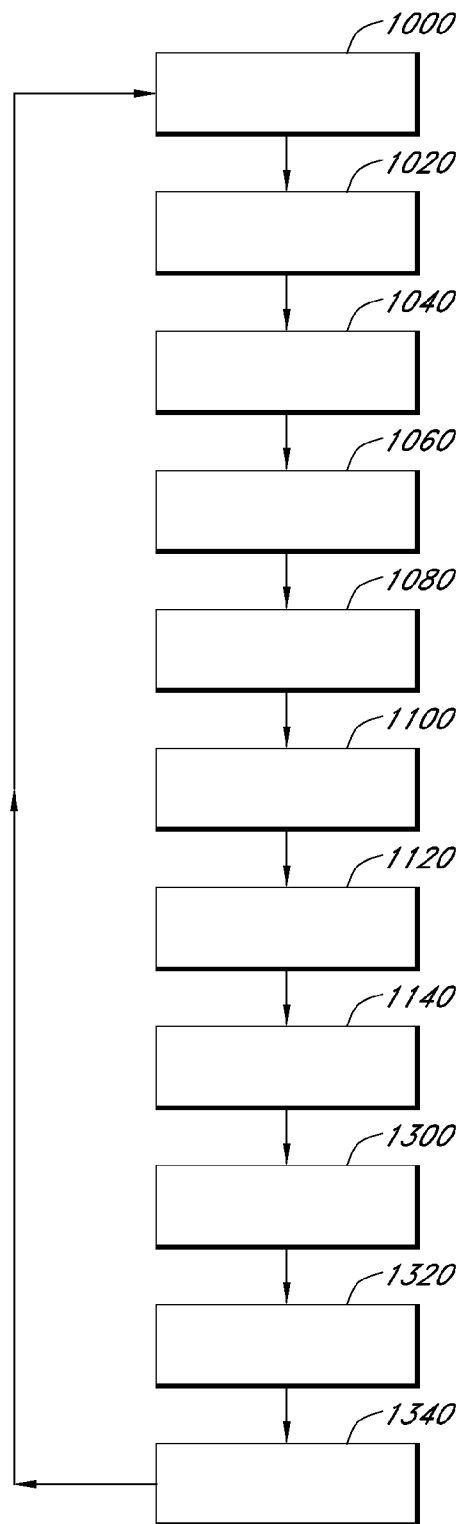


FIG. 7

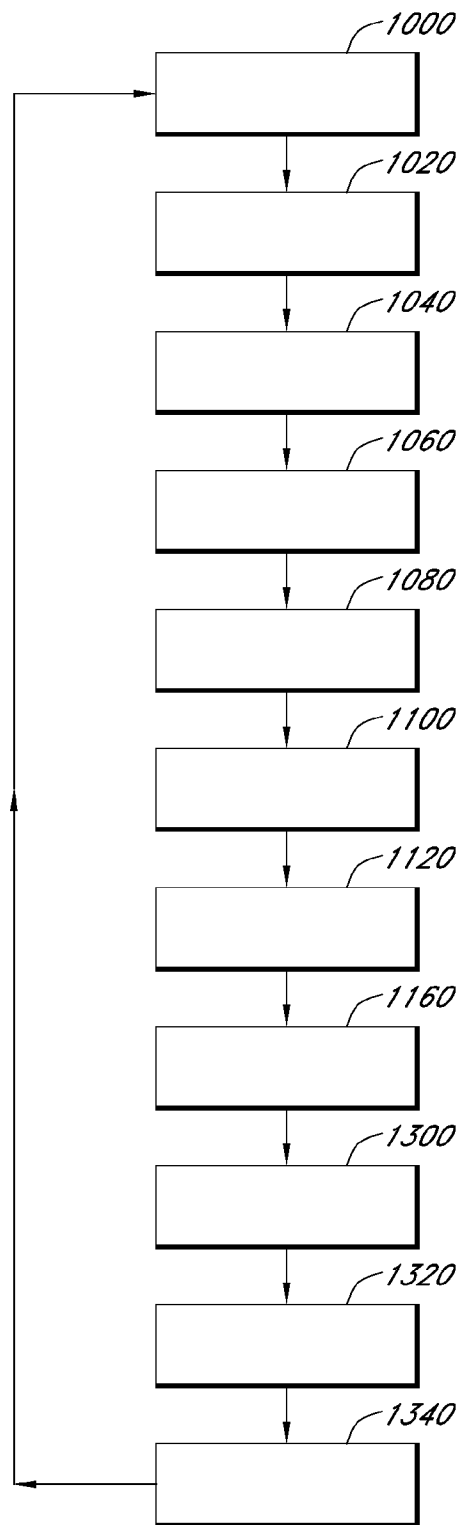


FIG. 8

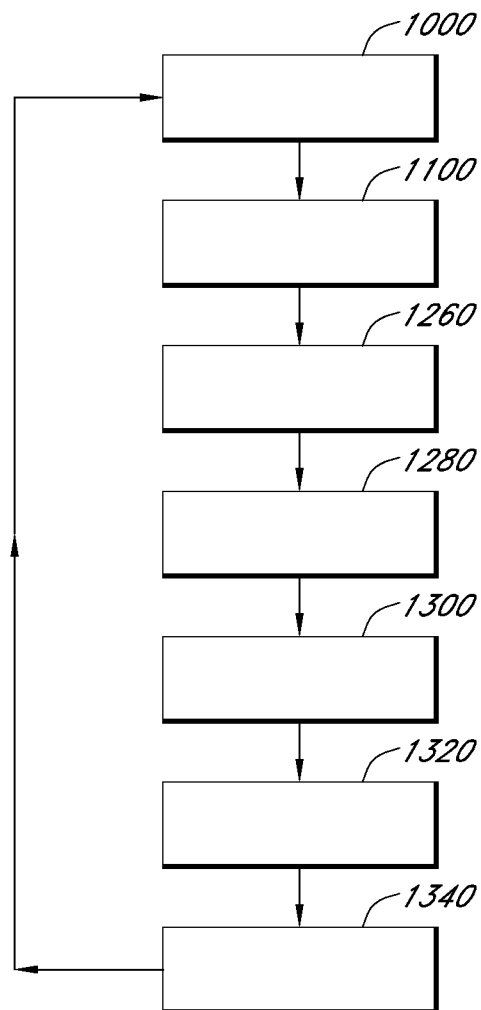


FIG. 9



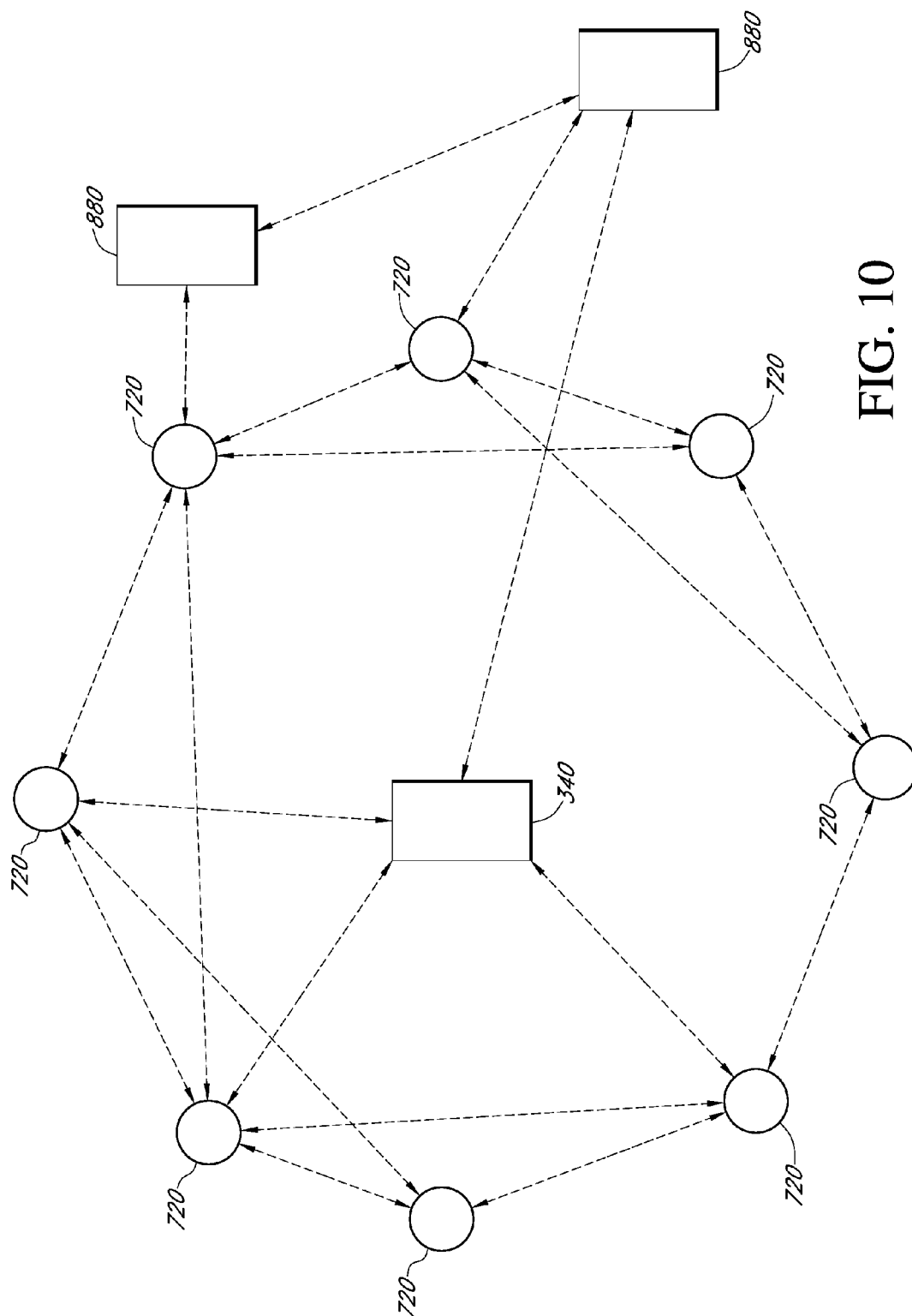


FIG. 10

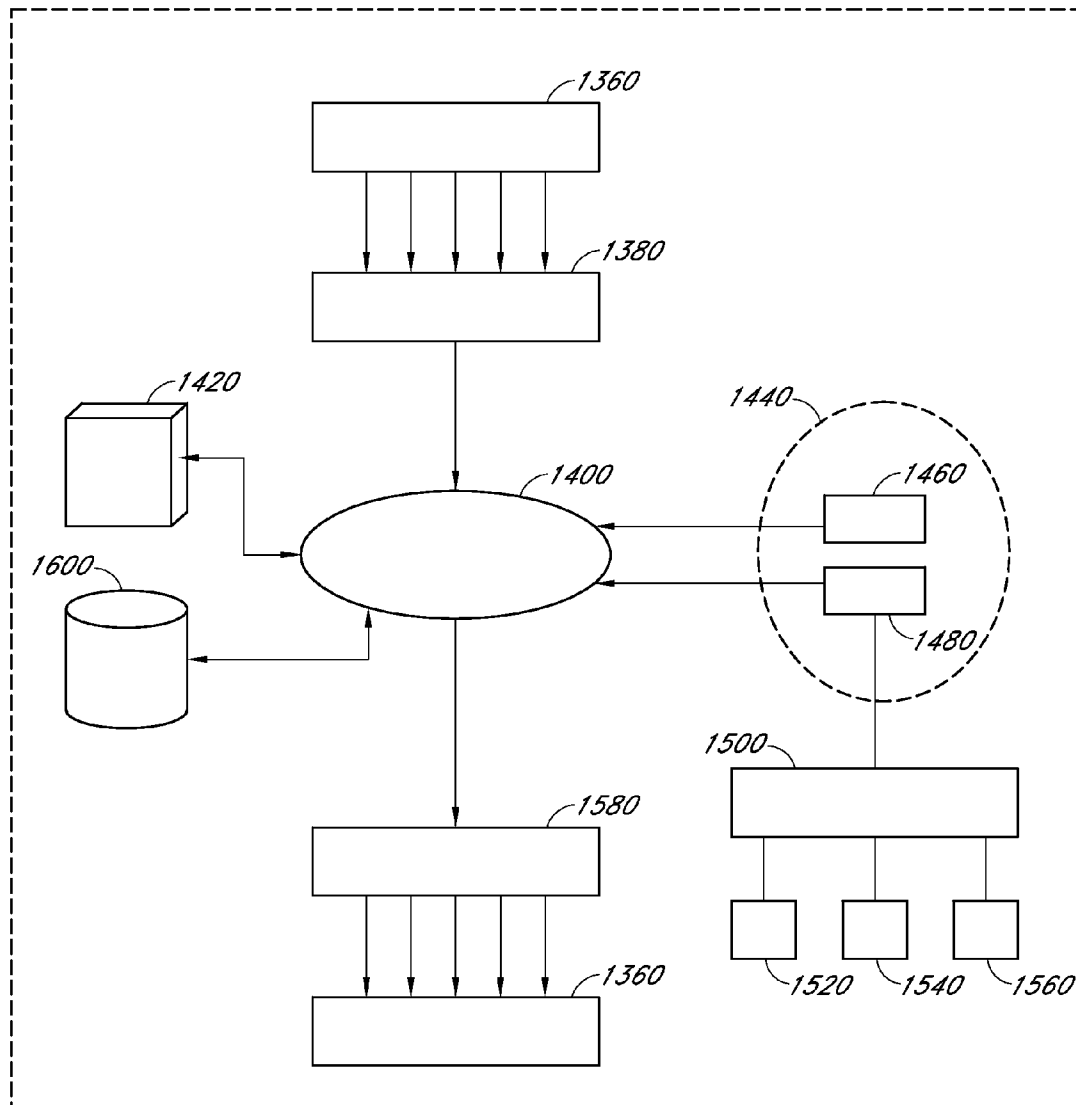


FIG. 11

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**DYNAMIC INTELLIGENT BIDIRECTIONAL  
OPTICAL ACCESS COMMUNICATION  
SYSTEM WITH OBJECT/INTELLIGENT  
APPLIANCE-TO-OBJECT/INTELLIGENT  
APPLIANCE INTERACTION**

**CROSS REFERENCE TO RELATED  
APPLICATIONS**

The present application is a continuation-in-part (CIP) of now pending U.S. non-provisional patent application entitled "Portable Internet Appliance", Ser. No. 12/238,286 filed on Sep. 25, 2008, and is a continuation-in-part (CIP) of U.S. non-provisional patent application entitled "Dynamic Intelligent Bidirectional Optical and Wireless Access Communication System", Ser. No. 11/952,001 filed on Dec. 6, 2007, which issued as U.S. Pat. No. 8,073,331, which claims the benefit of priority to U.S. provisional patent application entitled "Dynamic Intelligent Bidirectional Optical Access Communication System With Object/Intelligent Appliance-To-Object/Intelligent Appliance Interaction", Ser. No. 61/404,504 filed on Oct. 5, 2010, U.S. provisional patent application entitled "Intelligent Internet Device", Ser. No. 60/970,487 filed on Sep. 6, 2007, U.S. provisional patent application entitled "Wavelength Shifted Dynamic Bidirectional System", Ser. No. 60/883,727 filed on Jan. 6, 2007, and U.S. provisional patent application entitled "Wavelength Shifted Dynamic Bidirectional System", Ser. No. 60/868,838 filed on Dec. 6, 2006, which are all incorporated by reference as if reproduced herein in their entirety.

**FIELD OF THE INVENTION**

Bandwidth demand and total deployment cost (capital cost and operational cost) of an advanced optical access communication system are increasing, while a return on investment is decreasing. This has created a significant business dilemma.

More than ever before, we have become more mobile and global. An intelligent pervasive and always-on Internet access via convergence of all (e.g., an electrical/optical/radio/electro-magnetic/sensor/bio-sensor) communication networks can provide connectivity at anytime, from anywhere, to anything is desired.

The present invention is related to a dynamic bidirectional optical access communication system with an intelligent subscriber subsystem can connect/couple/interact (via one or more or all electrical/optical/radio/electro-magnetic/sensor/bio-sensor communication network(s) within and/or to and/or from an intelligent subscriber subsystems) with another object and an intelligent appliance utilizing an Internet protocol version 6 (IPv6) and its subsequent versions.

An intelligent subscriber system and/or an object and/or an intelligent appliance comprises one/more of the following modules (wherein a module is defined as a functional integration of critical electrical/optical/radio/sensor components, circuits and algorithms/stacks-needed to achieve a desired function/property of a module): a laser, a photodiode, a modulator, a demodulator, a phase-to-intensity converter, an amplifier, a wavelength combiner/decombiner, an optical power combiner/decombiner, a cyclic arrayed waveguide router, a micro-electrical-mechanical-systems (MEMS) space switch, an optical switch, an optical circulator, an optical filter, an optical intensity attenuator, a processor, a memory, a display, a microphone, a camera, a sensor, a biological sensor, a radio, a near-field-communication, a scanner, a power source, (b) an embedded and/or a cloud based operating system software module (wherein a software mod-

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ule is defined as a functional integration of critical algorithms/stacks-needed to achieve a desired function/property of a software module) and/or (c) an embedded and/or a cloud based intelligence rendering software module.

Furthermore, an object can sense/measure/collect/aggregate/compare/map and connect/couple/interact (via one or more or all electrical/optical/radio/electro-magnetic/sensor/bio-sensor communication network(s) within and/or to and/or from an object) with another object, an intelligent subscriber subsystem and an intelligent appliance utilizing an Internet protocol version 6 (IPv6) and its subsequent versions.

**SUMMARY OF THE INVENTION**

A dynamic intelligent bidirectional optical access communication system utilizes two critical optical modules: a phase modulator and an intensity modulator at an intelligent subscriber subsystem. Together, these two critical optical modules can reduce the Rayleigh backscattering effect on the propagation of optical signals.

Reduced Rayleigh backscattering effect can enable a longer-reach optical access communication network (longer-reach than that of a currently deployed optical access communication network) between an intelligent subscriber subsystem and a super node (e.g., many neighbouring nodes collapsed into a preferred super node). Such a longer-reach optical access communication network eliminates significant costs related to a vast array of middle equipment (e.g., a router/switch) which otherwise would be needed between a standard node (without a super node configuration) and a large number of remote nodes, according to a currently deployed optical access communication network.

In one key embodiment of the present invention, a bidirectional optical access communication system can be configured to be capable of a longer-reach optical access communication network.

In another key embodiment of the present invention, a bidirectional optical access communication system can be configured to be capable of dynamically providing wavelength on-Demand and/or bandwidth on-Demand and/or service on-Demand.

In another key embodiment of the present invention, a construction of a wavelength-tunable laser component/module is described.

In another key embodiment of the present invention, an optical signal can be routed to an intended destination securely by extracting an intended destination from a destination marker optical signal.

In another key embodiment of the present invention, a construction and applications of an object is described.

In another key embodiment of the present invention, an object can sense/measure/collect/aggregate/compare/map and connect/couple/interact (via one or more or all electrical/optical/radio/electro-magnetic/sensor/bio-sensor communication network(s) within and/or to and/or from an object) with another object, an intelligent subscriber subsystem and an intelligent appliance utilizing an Internet protocol version 6 (IPv6) and its subsequent versions.

In another key embodiment of the present invention, an intelligence rendering software module allows a subscriber subsystem to adapt/learn/relearn a user's interests/preferences/patterns and thereby rendering an intelligence to a subscriber subsystem.

In another key embodiment of the present invention, an intelligence rendering software module allows an appliance

to adapt/learn/relearn a user's interests/preferences/patterns and thereby rendering an intelligence to an appliance.

In another key embodiment of the present invention, a construction of a near-field communication (NFC) enabled micro-subsystem/intelligent appliance is described.

In another key embodiment of the present invention, a portfolio of key applications (e.g., an intelligent, location based and personalized social network and direct/peer-to-peer marketing) are also described.

The present invention can be better understood in the description below with accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a block diagram construction (configuration) of a bidirectional optical access communication network **100**, according to one embodiment of the present invention.

FIG. 2 illustrates a block diagram construction (configuration) of a dynamic bidirectional optical access communication network **100**, according to another embodiment of the present invention.

FIG. 3 illustrates a block diagram construction (configuration) of an optical processing micro-subsystem **360** (within an intelligent subscriber subsystem), according to another embodiment of the present invention.

FIG. 3A illustrates a block diagram construction (configuration) of a wavelength tunable (narrowly) laser component, according to another embodiment of the present invention.

FIG. 3B illustrates a block diagram construction (configuration) of a wavelength tunable (widely) laser array module, according to another embodiment of the present invention.

FIG. 4 illustrates a block diagram construction (configuration) of an intelligent subscriber subsystem **340**, according to another embodiment of the present invention.

FIG. 5 illustrates a block diagram construction (configuration) of an object **720**, according to another embodiment of the present invention.

FIG. 6 illustrates a block diagram construction (configuration) of an intelligent appliance **880**, according to another embodiment of the present invention.

FIG. 7 illustrates a block diagram method flow-chart (configuration) of an intelligent, location based and personalized social network, according to another embodiment of the present invention.

FIG. 8 illustrates a block diagram method flow-chart (configuration) of an intelligent, location based and personalized direct marketing, according to another embodiment of the present invention.

FIG. 9 illustrates a block diagram method flow-chart (configuration) of an intelligent, location based and personalized secure contact-less (proximity) Internet access authentication, according to another embodiment of the present invention.

FIG. 10 illustrates a block diagram construction (configuration) of connections/couplings/interactions between an object **720** with another object **720**, an intelligent subscriber subsystem **340** and an intelligent appliance **880**, according to another embodiment of the present invention.

FIG. 11 illustrates a block diagram method flow-chart (configuration) enabling a task execution by a software agent, according to another embodiment of the present invention.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates a block diagram construction (configuration) of a bidirectional optical access communication net-

work **100**, which includes a super node **101**, many distant local nodes **102** and many distant remote nodes **103**. Distance between a super node **101** and a remote node **103** is greater than that between a super node **101** and a local node **102**. However, many local nodes **102** can collapse/reside within a super node **101** to enable a bidirectional optical access communication network **100** without a road-side electrical power requirement at a local node **102**.

A bidirectional optical access communication network **100** is connected/coupled/interacted with a super node **101**, many local nodes **102**, many remote nodes **103** and a large number of intelligent subscriber subsystems **340** (located at homes/businesses) over a dispersion-compensated single-mode optical fiber. At a super node **101**, a number of laser modules (high power fast wavelength switching-wavelength tunable semiconductor laser modules are preferred) **120** provide first set of downstream wavelengths, where each downstream wavelength is modulated at 10 Gb/s or higher Gb/s, by a corresponding intensity modulator module (an electro-absorption/Mach-Zehnder intensity modulator module is preferred) **140** to provide optical signals. These modulated downstream wavelengths (embedded with the optical signals) are combined by a wavelength combiner module **160** and amplified by an erbium-doped fiber amplifier (EDFA) module **220**. These amplified downstream wavelengths are passed through a 3-port circulator module **260** and transmitted over a dispersion-compensated single-mode optical fiber (with a distributed Raman amplifier is preferred) **280** to a remote node **103**. A distributed Raman amplifier can provide a distributed amplification of an optical signal over a dispersion-compensated single-mode optical fiber by a nonlinear coupling/interaction between an optical signal and an optical pump signal and thereby effectively increasing the reach of an optical access communication network than that of a currently deployed optical access communication network. At a remote node **103**, modulated downstream wavelengths from a super node **101**, are decombined by an integrated wavelength combiner/decombiner module **300**, filtered by a bandpass optical filter module (a wavelength switching-wavelength tunable bandpass optical filter module is preferred) **240**, are power split by an integrated optical power combiner/decombiner module **320** and are transmitted to a number of intelligent subscriber subsystems **340**. However, all the optical modules at a remote node **103** must be temperature-insensitive to operate within a wide temperature range at a remote node **103**, as there may not be an electrical power at a remote node **103**. The downstream wavelength from a super node **101** to a number of intelligent subscriber subsystems **340** can be transmitted and correspondingly received by photodiode modules **200** at intelligent subscriber subsystems **340**, utilizing a time division multiplexed statistical bandwidth allocation and/or a broadcasting method.

A local node **102** includes a laser module **120**, which is connected/coupled/interacted with an erbium-doped fiber amplifier (EDFA) module **220** to provide an upstream wavelength from intelligent subscriber subsystems **340**, which is offset in wavelength with respect to the first set of downstream wavelengths generated at a super node **101**. The upstream wavelength power splits through an integrated optical power combiner/decombiner module **320** at a remote node **103** and is transmitted to a number of intelligent subscriber subsystems **340** for optical processing within an optical processing micro-subsystem **360**. An optically processed upstream wavelength (embedded with the optical signals) within an optical processing micro-subsystem **360** (within an intelligent subscriber subsystem **340**) is looped/returned back through an integrated optical power combiner/decombiner

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module **320**, a bandpass optical filter module **240** and an integrated wavelength combiner/decombiner module **300** at a remote node **103**. An optically processed upstream wavelength is transmitted over a dispersion-compensated single-mode optical fiber **280** and passed through a 3-port circulator module **260** at a super node **101**. A 3-port circulator module **260** provides an upstream wavelength from a number of intelligent subscriber subsystems **340** to a bandpass optical filter **240**, an erbium-doped fiber amplifier (EDFA) module **220**, a wavelength decombiner module **180**, a number of external fiber-optic interferometer module **180A** (to convert a phase modulation signal into an intensity modulation signal) and a photodiode module **200** at a super node **101**, wherein each photodiode module **200** is detecting a distinct upstream wavelength. Furthermore, a photodiode module **200** comprises one or more of the following optical/electronic components: a 10 Gb/s or higher Gb/s linear photodiode chip, a 10 Gb/s or higher Gb/s mesa-type/waveguide-type avalanche photodiode chip (APD), a 10 Gb/s or higher Gb/s burst-mode trans-impedance amplifier, a 10 Gb/s or higher Gb/s clock and data recovery (CDR), a bandpass optical filter **240** and a semiconductor optical amplifier **380** (if a semiconductor optical amplifier **380** is needed for an optical gain in conjunction with a 10 Gb/s or higher Gb/s linear photodiode chip). The upstream wavelength from a number of intelligent subscriber subsystems **340** to a super node can be transmitted and correspondingly received by photodiode modules **200** at a super node **101**, utilizing a time division multiplexed statistical bandwidth allocation and/or a broadcasting method.

FIG. 2 illustrates a block diagram construction (configuration) of a dynamic bidirectional optical access communication network **100**, where a wavelength to an intelligent subscriber subsystem **340** can be dynamically varied on-Demand by utilizing an M:M cyclic wavelength arrayed waveguide grating router module (a fast wavelength switching-wavelength tunable programmable M:M cyclic wavelength arrayed waveguide grating router module is preferred) **250** at a remote node **103**. All possible switched output downstream wavelengths are arranged at the M outputs of an M:M cyclic wavelength arrayed waveguide grating router module **250** because of its free spectral range periodic property of an M:M cyclic wavelength arrayed waveguide grating router module. This construction (configuration) offers a flexibility of dynamically routing/delivering one or more downstream wavelength with different modulation rates (e.g., 10 Gb/s or higher Gb/s) provided by a corresponding intensity modulator module **140**, to an intelligent subscriber subsystem **340** for wavelength on-Demand, bandwidth on-Demand and service on-Demand, significantly increasing a return on investment. Thus each dynamically routed wavelength with a specific modulation rate can provide a distinct bandwidth-specific service on-Demand (e.g., an ultra-high definition movie on-Demand) to an intelligent subscriber subsystem **340**.

A method of providing bandwidth-specific service on-Demand can be realized by comprising at least the steps of (a) a user requesting a specific service (e.g., an ultra-high definition movie on-Demand) at an intelligent subscriber subsystem **340**, (b) delivering the specific service over a wavelength by a laser module **120** at a super node **101**, (c) modulating the wavelength at a required modulation rate (e.g., 10 Gb/s or higher Gb/s) by an intensity modulator module **140** at a super node **101** and (d) dynamically routing the said wavelength (embedded with a user requested specific service) by an M:M cyclic wavelength arrayed waveguide grating router module **250** to a remote node **103** and to an intelligent subscriber subsystem **340**.

Thus a rapid wavelength routing (in space, wavelength and time) by an M:M cyclic wavelength arrayed waveguide grat-

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ing router module **250** can be constructed as an optical packet/interconnect router between many printed circuit boards/integrated circuits/microprocessors.

Furthermore, outputs of an M:M cyclic wavelength arrayed waveguide grating router module **250** at a remote node **103** can be connected/coupled/interacted with inputs of a large scale N:N (e.g., a 1000:1000) micro-electrical-mechanical-systems (MEMS) space switch module at a remote node **103** to provide a much greater flexibility of wavelength routing.

An input-output echelle grating module and a negative-index photonic crystal super-prism module can be utilized as alternatives to a wavelength combiner module **160**, a wavelength decombiner module **180** and an integrated wavelength combiner/decombiner module **300**. A multi-mode interference (MMI) module and Y-combiner module can be utilized as alternatives to an integrated optical power combiner/decombiner module **320** and optical power combiner module **320A**.

FIG. 3 illustrates a block diagram construction (configuration) of an optical processing micro-subsystem **360**, wherein downstream wavelength is passed through a 3-port circulator **260**, a bandpass optical filter module **240** and a photodiode module **200**. A wavelength from a laser module **120** at local node **102** is passed through a 3-port circulator module **260** within an optical processing micro-subsystem **360** and this wavelength is amplified by a semiconductor optical amplifier module **380**, modulated in phase by a phase modulator module **400**, modulated at a bit-rate (e.g., 10 Gb/s or higher Gb/s, but a variable modulation bit-rate is preferred) in intensity by an intensity modulator module **420**, amplified by a semiconductor optical amplifier module **380**, transmitted through a variable optical intensity attenuator module **440** (if needed) and looped/returned back to create an upstream wavelength (embedded with an optical signal) and transmitted to a super node **101**.

Furthermore, a generic intensity modulator module **140** can replace an electro-absorption intensity modulator module **420**, which is designed for an integration with a semiconductor optical amplifier module **380**, a phase modulator module **400** and a variable optical intensity attenuator module **440** on a monolithic photonic integrated circuit (PIC) and/or an active-passive hybrid planar lightwave circuit (PLC) technology.

Numerous permutations (e.g., modulating a CW optical signal from a laser module **120** at a local node **102** by an intensity modulator **140/420** and then by a phase modulator **400**) of all optical modules within an optical processing micro-subsystem **360** are possible to create an optimum quality of an upstream wavelength for an intended reach. Use of a phase modulator module **400** and an intensity modulator module **420** together can reduce the Rayleigh backscattering effect on the propagation of optical signals, enabling a longer-reach optical access communication network between a super node **101** and a remote node **103**, thus eliminating a vast array of middle equipment such as routers and switches, which would otherwise be needed between a standard node (without a super node configuration) and a large number of remote nodes **103**, according to a currently deployed optical access communication network.

According to another embodiment of the present invention, an upstream second set of wavelengths (which are offset in wavelengths with respect to first set of wavelengths transmitted from a super node **101**), can be internally generated by a wavelength-tunable laser module within an intelligent subscriber subsystem **340**, without a need of an external wavelength generation by a laser module **120** at a local node **102**. Generation of an upstream wavelength (fast switching-widely tunable laser module is preferred) within an intelligent

subscriber subsystem **340** simplifies a construction of a dynamic bidirectional optical access communication network **100**.

According to another embodiment of the present invention, a single-mode/mode-hopp free wavelength tunable (about 32 nm) laser module can be constructed by utilizing an ultra-low anti-reflection coated (both facets) semiconductor optical amplifier (a photonic crystal/aka quantum dot semiconductor optical amplifier is preferred) and a triple-ring resonator waveguide on a planar lightwave circuit (PLC) platform. The front facet of a triple-ring resonator waveguide has an ultra-low anti-reflection coating, while the back facet of that has a high-reflection coating. The anti-reflection coated back facet of a semiconductor optical amplifier and the anti-reflection coated front facet of a triple-ring resonator waveguide are intimately attached ("butt-coupled") to each other. The phases of a triple-ring resonator waveguide can be controlled by a metal strip heater along a straight segment of a triple-ring resonator waveguide. Furthermore, a semiconductor optical amplifier can be monolithically integrated with an electro-absorption/Mach Zehnder intensity modulator.

FIG. 3A illustrates a block diagram construction (configuration) of a single-mode/mode-hopp free wavelength tunable (narrow) laser component, comprising an electro-absorption modulator (EAM) segment **400** (about 150 micron long), which can be integrated ("butt-coupled") with the back facet

of a  $\lambda/4$  phase shifted DR laser ( $\lambda/4$  phase shifted distributed feed back (DFB) section (about 400 micron long)+phase control section (without any gratings/about 50 micron long)+distributed Bragg reflector (DBR) section (about 50 micron long)) **120A**. Laser multi-quantum-well (MQW) layers can be stacked on top of electro-absorption intensity modulator (EAM) multi-quantum-well (MQW) layers. An electro-absorption intensity modulator (EAM) can be processed by etching away the laser multi-quantum-well MQW layers. Higher laser output (exit power) can be achieved by incorporating distributed phase shifts and/or chirped grating across the length of a distributed feedback (DFB) section. An injection current to a phase control section can produce a change in distributed feed back (DFB) laser wavelength. A reverse-voltage to an electro-absorption intensity modulator (EAM) **420** can change in a refractive index by Quantum Confined Stark Effect (QCSE). The advantages of this tunable laser design are (1) high single-mode stability due to a distributed feed back (DFB) section, (2) higher output (exit) power due to a distributed Bragg reflector (DBR) section and (3) rapid wavelength tuning by an injection current to a phase control section and/or reverse voltage to an electro-absorption intensity modulator (EAM) **420**.

A stacked multi-quantum well (MQW) cross-sectional layer design of an electro-absorption modulator (EAM) with a DR laser is illustrated in table 1 below.

TABLE 1

	Thickness (nm)	N-/P-Doping (10 <sup>18</sup> /cm <sup>3</sup> )	Composition In(1-x)Ga(x)As(y)P(1-y)	Bandgap Wavelength (nm)	Strain (%)	Material Index
Substrate	100 × 10 <sup>3</sup>	N 3.0	X = 0.000 Y = 0.000	918.6	0	3.1694
Buffer	1 × 10 <sup>3</sup>	N 1.0	X = 0.000 Y = 0.000	918.6	0	3.1694
1.15Q	70	N 0.5	X = 0.181 Y = 0.395	1150	0	3.3069
1.20Q	50	N 0.5	X = 0.216 Y = 0.469	1200	0	3.3345
1.10Q	10	N 0.001	X = 0.145 Y = 0.317	1100	0	3.2784
EAM Well-1	8	N 0.001	X = 0.463 Y = 0.930	1550	TS0.2	3.5533
1.10Q	6	N 0.001	X = 0.145 Y = 0.317	1100	0	3.2784
EAM Well-2	8	N 0.001	X = 0.463 Y = 0.930	1550	TS0.2	3.5533
1.10Q	6	N 0.001	X = 0.145 Y = 0.317	1100	0	3.2784
EAM Well-3	8	N 0.001	X = 0.463 Y = 0.930	1550	TS0.2	3.5533
1.10Q	6	N 0.001	X = 0.145 Y = 0.317	1100	0	3.2784
EAM Well-4	8	N 0.001	X = 0.463 Y = 0.930	1550	TS0.2	3.5533
1.10Q	6	N 0.001	X = 0.145 Y = 0.317	1100	0	3.2784
EAM Well-5	8	N 0.001	X = 0.463 Y = 0.930	1550	TS0.2	3.5533
1.10Q	6	N 0.001	X = 0.145 Y = 0.317	1100	0	3.2784
EAM Well-6	8	N 0.001	X = 0.463 Y = 0.930	1550	TS0.2	3.5533
1.10Q	10	N 0.001	X = 0.145 Y = 0.317	1100	0	3.2784
Stop-Etch	50	N 0.001	X = 0.000 Y = 0.000	918.6	0	3.1694
*1.25Q	10	N 0.001	X = 0.239 Y = 0.533	1250	0	3.3588
*DR Well-1	5	N 0.001	X = 0.239 Y = 0.839	1642	CS1.05	3.4971
*1.25Q	10	N 0.001	X = 0.239 Y = 0.533	1250	0	3.3588
*DR Well-2	6	N 0.001	X = 0.239 Y = 0.839	1642	CS1.05	3.4971
*1.25Q	10	N 0.001	X = 0.239 Y = 0.533	1250	0	3.3588
*DR Well-3	5	N 0.001	X = 0.239 Y = 0.839	1642	CS1.05	3.4971
*1.25Q	10	N 0.001	X = 0.239 Y = 0.533	1250	0	3.3588
*DR Well-4	6	N 0.001	X = 0.239 Y = 0.839	1642	CS1.05	3.4971
*1.25Q	10	N 0.001	X = 0.239 Y = 0.533	1250	0	3.3588
*1.20Q	50	P 0.2	X = 0.216 Y = 0.469	1200	0	3.3345
**Grating:	50	P 0.2	X = 0.181 Y = 0.395	1150	0	3.3069
1.15Q						
Cladding	1.5 × 10 <sup>3</sup>	P 0.2~P 2.0	X = 0.000 Y = 0.000	918.6	0	3.1694
1.30Q	50	P 5.0	X = 0.280 Y = 0.606	1300	0	3.3871
Cap	200	P 30	X = 0.468 Y = 1.000	1654	0	3.5610

EAM: Electro-absorption modulator

DR: Laser

TS: Tensile

CS: Compressive

\*These laser layers must be removed in EAM section and be replaced/re-grown with InP layer of total thickness of ~172 nm.

\*\* $\lambda/4$  phase shifted gratings (at the DFB section of DR laser) are fabricated on this layer with 50% duty cycle at 40 nm grating etch depth.

FIG. 3B illustrates a block diagram construction (configuration) of a single-mode/mode-hopp free wavelength tunable (widely) laser array, which can be integrated with a wavelength combiner 160 or a Y/multi-mode interference optical power combiner 320A, a tilted/curved semiconductor optical amplifier 380, a phase modulator 400 (if needed), an intensity modulator 140/420 and a tilted/curved semiconductor optical amplifier 380 via an waveguide 280A/single-mode fiber 280. The back facet of an electro-absorption modulator (EAM) segment 400 has a low anti-reflection coating, while the front facet of a last optical modulator 380 an ultra-low anti-reflection coating. An upstream wavelength (embedded with an optical signal) generated utilizing a tunable laser module at an intelligent subscriber subsystem 340, is passed through a 3-port circulator module 260 at a remote node 103 and transmitted to a super node 101. A downstream wavelength from a super node 101, is passed through a 3-port circulator 260, a bandpass optical filter module 240 and a photodiode module 200 at a remote node.

According to another embodiment of the present invention, that a subset of a second set of wavelengths (which are offset in wavelengths with respect to a first set of wavelengths transmitted from the super node 101) can be modulated at a bit-rate (e.g., 10 Gb/s or higher Gb/s, but a variable modulation bit-rate is preferred) and thus configured to be shared with a number of intelligent subscriber subsystems 340 to generate a symmetric upstream bandwidth/bandwidth on-Demand.

Both downstream and upstream wavelengths can be protected by a 2x2 optical protection switch module and separated via an optical ring-network comprising of redundant/multiple dispersion-compensated single-mode optical fibers 280.

A pilot tone modulation can be added to a semiconductor optical amplifier module 380 within an optical processing micro-subsystem 360 (within an intelligent subscriber subsystem 340) and to laser modules 120 (at a super node 101 and a local node 102) to reduce Rayleigh backscattering effect.

An electronic dispersion compensation circuit and a forward error correction circuit can be added to relax the specifications of optical and/or electronic modules. Furthermore, all optical single-mode fibers can be polished at an angle (about 7 degree) to reduce any optical back-reflection.

According to another embodiment of the present invention, an upstream wavelength may be shared/transmitted by a number of intelligent subscriber subsystems 340 utilizing a time division multiplexed statistical bandwidth allocation method. Therefore, a burst mode receiver circuit is needed at a super node 101 to process bursty optical signals embedded in the upstream wavelengths from a number of intelligent subscriber subsystems 340.

Furthermore, to enable a higher bit-rate, a modulator/demodulator of an advanced modulation format (e.g., differential quadratic phase-shift keying-DQPSK and/or quadratic amplitude modulation-QAM) can be utilized.

FIG. 4 illustrates a block diagram construction (configuration) of an intelligent subscriber subsystem 340, according to another embodiment of the present invention, wherein an intelligent subscriber subsystem 340 comprises an optical processing micro-subsystem 360 (for separating and providing a downstream wavelength to a photodiode module 200 and optically processing an upstream wavelength to a super node 101). A photodiode module 200 within an optical processing micro-subsystem 360 is connected/coupled/interacted with an optical-to-electrical amplifier circuit 460 and a media access controller (with processing, routing and quality of service (QoS) functions) module and a module specific

software 480. A media access controller module and a module specific software 480 is connected/coupled/interacted with one or more of the following: (a) an IP/micro IP/light weight IP address module and a module specific software 500, (b) security module (an Internet firewall/spyware/user-specific security control/authentication) and a module specific software 520, (c) an in-situ/remote diagnostic module and a module specific software 540, (d) a content transfer module and a module specific software 560, (e) a time-shift (time-shift is a recording of content to a storage medium for consuming at a later time) module and a module specific software 580, (f) a place-shift (place-shift is consuming a stored content on a remote appliance/subsystem/system/terminal via an Internet) module and a module specific software 600, (g) a content (voice-video-multimedia-data) over-IP module and a module specific software 620, (h) a radio module (with antenna(s)), wherein the radio module comprises one or more of the following modules: a RFID (active/passive), a Wibree, a Bluetooth, a Wi-Fi, an ultra-wideband, a 60-GHz/millimeter wave, a Wi-Max/4G/higher frequency radio and an indoor/outdoor position module (e.g., a Bluetooth, a Wi-Fi, a GPS and an electronic compass) and a module specific software 640, (i) a software module 700, which comprises one or more of the following: an embedded/cloud based operating system software and an embedded/cloud based intelligence rendering software (e.g., a surveillance software, a behavior modeling ([www.choicestream.com](http://www.choicestream.com)), a predictive analytics/text/data/pattern mining/natural language ([www.sas.com](http://www.sas.com)), a fuzzy logic/artificial intelligence/neural network ([www.nd.com/bliasoft.com](http://www.nd.com/bliasoft.com)), a machine learning/iterative learn-by-doing/natural learning ([www.saffron.com](http://www.saffron.com)) and an intelligent agent ([cougaarsoftware.com](http://cougaarsoftware.com)), (j) a memory/storage module and a module specific software 780, (k) a sensor module and a module specific software 820 and (l) a battery/solar cell/micro fuel-cell/wired power supply module and a module specific software 840.

Furthermore, a system-on-a-chip, integrating a processor module and a module specific software 760 with a graphic processor module, an Internet firewall, a spyware and a user-specific security control/authentication can simplify a construction of an intelligent subscriber subsystem 340.

An intelligent subscriber subsystem 340 comprises a set top box/personal video recorder/personal server components/modules. An intelligent subscriber subsystem 340 comprises a voice-to-text-to-voice processing module and a module specific software. (e.g., Crisp Sound is a real time audio signal processing software for echo cancellation, background noise reduction, speech enhancement and equalization), a video compression module and a module specific software, a photo-editing software module and a software module for automatically uploading content to a preferred remote/cloud server.

An intelligent subscriber subsystem 340 has multiple radio modules with multiple antennas. A tunable radio-frequency carbon nano-tube (CNT) cavity can tune in between 2 GHz and 3 GHz. Merging many antennas utilizing a tunable carbon nano-tube (CNT) cavity and an analog/digital converter, it can enable a simplified software-defined radio.

An intelligent subscriber subsystem 340 that it can enable content over-IP, (e.g., Skype service) thus disrupting a traditional carrier controlled fixed telephony business model.

According to another embodiment of the present invention, a secure delivery of a content optical signal to an intended destination can be achieved by utilizing a low bit-rate destination marker optical signal, which is modulated at a different plane with a different modulation format, simultaneously in conjunction with a higher-bit rate content optical signal. The low bit-rate destination marker optical signal is extracted and



converted from an optical domain to an electrical domain to determine an intended destination of a content optical signal, while a content optical signal remains in an optical domain until it is delivered to an intended destination—thus both routing and security in the delivery of a content optical signal are significantly enhanced.

FIG. 5 illustrates a block diagram construction (configuration) of a micro-sized (about 15 mm<sup>3</sup>) object **720**, having a processor (e.g., ultra-lower power consumption ARM Cortex™-M3/micro-controller-www.ambiqmicro.com/based on nano-scaled InAs XOI) module and a module specific software **760** is connected/coupled/interacted with one or more of the following: (a) an IP/micro IP/light weight IP address module and a module specific software **500**, (b) a software module **700** (e.g., a Tiny OS-operating system/IBM mote runner), (c) an “object specific” radio module with antenna(s) (which comprises one or more of the following, a RFID (active/passive), an ultra-low power radio, a Wibree, a Bluetooth and a near-field communication (NFC) **740**, (d) a memory/storage module and a module specific software **780**, (e) a camera module (a MEMS based camera is preferred) and a module specific software **800**, (f) a sensor (e.g., a radio enabled micro-electro-mechanical sensor) module and a module specific software **820** and (g) a battery/solar cell/micro fuel-cell wired power supply/wired power supply module and a module specific software **840**.

A battery/solar cell (e.g., Silicon)/micro fuel-cell/wired power supply/resonant electro-magnetic inductive coupling energy transfer (wireless) power supply module and a module specific software **840** can include a thick/thin film (e.g., 3.6V 12 μAh Cymbet thin-film lithium battery) printed/3-D/nano-engineered battery (e.g., cellulose-a spacer ionic liquid electrolyte, electrically connected/coupled/interacted with a carbon nano-tube (CNT) electrode and a Lithium Oxide electrode), a nano-super-capacitor (e.g., utilizing carbon nano-tube (CNT) ink, or operating due to fast ion transport at a nano-scale), a nano-electrical generator of piezoelectric PZT nano-wires (e.g., n-/p-type Zinc Oxide nano-wires. 20,000 Zinc Oxide nano-wires can generate about 2 mW), a nano-electro-mechanical systems (NEMS) cell (e.g., a motor protein cell) and a microbial nano fuel-cell.

A motor protein (macromolecule) named prestin, which is expressed in outer hair cells in the organ of Corti of a human ear and it is encoded by the SLC26A5 gene. Prestin converts an electrical voltage into a motion by elongating and contracting outer hair cells. This motion amplifies sound in a human ear. However, prestin can work in a reverse mode, producing an electrical voltage in response to a motion. To increase conductivity, a microbe (e.g., a bacterium Pili) can act as a conducting nano-wire to transfer electrons generated by prestin. Each prestin is capable of making only nano watts of electricity. A prestin cell (array of prestins, connected/coupled/interacted between two electrodes) can electrically charge a battery/solar cell/micro fuel-cell/wired power supply module. A prestin cell can grow and self-heal, as it is constructed from biological components. Furthermore, a nano-electrical generator of piezoelectric PZT nano-wires can be integrated with prestin.

A memristor component can replace both a processor component and/or a memory/storage component. Furthermore, a memristor component and a nano-sized radio component can reduce power consumption of an object **720**.

A sensor module and a module specific software **820** can include a biological sensor (e.g., to monitor/measure a body temperature, % oxygen, a heart rhythm, a blood glucose concentration and a bio-marker for a disease parameter).

An object **720** with a biological/bio-marker sensor, a transistor, a LED, a nano-sized radio, a prestin cell and an object specific software can be incorporated onto a support material (e.g., a silk membrane) to monitor/measure (and transmit) a disease parameter.

Another example of a biological sensor can be described as follows: an assassin protein (macromolecule) perforin is immune system’s weapon of mass destruction. Perforin is encoded by the PRFI gene. Perforin is expressed in T cells and natural killer (NK) cells. Interestingly, perforin resembles a cellular weapon employed by a bacterium (e.g., anthrax). Perforin has an ability to embed itself to form a pore in a cell-membrane. The pore by itself may be damaging to a cell and it enables an entry of a toxic enzyme granzyme B, which induces an apoptosis (a programmed suicide process) of a diseased cell. However, perforin occasionally misfires—killing a wrong cell (e.g., an insulin producing pancreas) and significantly accelerating a disease like diabetes. Defective perforin leads to an upsurge in cancer malignancy (e.g., leukemia). Up regulation of perforin can be effective against cancer and/or an acute viral disease (e.g., cerebral malaria). Down regulation of perforin can be effective against diabetes. The ramification of a pore-forming macromolecule like perforin is enormous, if it can be tailored/tuned to a specific disease.

Like perforin, an ultrasonically guided micro-bubble can break in a cell-membrane. A pore-forming micro-bubble (ultrasonically guided)/nano-vessel (e.g., a cubosome/liposome) encapsulating a suitable chemical(s)/drug(s), a surface modified-red fluorescent protein (e.g., E2-Crimson) and perforin (if needed) can be an effective imaging/drug delivery method. A surface coating (e.g., a pegylation) on a micro-bubble/nano-vessel can avoid an immune surveillance of a human body. A surface coating of disease-specific ligand (e.g., an antibody) on a micro-bubble/nano-vessel can enhance the targeting to specific disease cells. Furthermore, an encapsulation of magnetic super-paramagnetic nano-particles within a micro-bubble/nano-vessel can significantly enhance the targeting to specific disease cells, when it is guided by a magnet. A micro-bubble/nano-vessel can be incorporated within a silicone micro-catheter (silver nano-particle coated) tube or a micro-electrical-mechanical-systems (MEMS) reservoir/micro-pump (integrated with an array of silicon micro-needles) on a support material.

For utilizing an object **720** within and/or on a human body, all components must be biocompatible (bio-dissolvable is preferred).

If a disease parameter measurement is perceived to be abnormal with respect to a reference disease parameter measurement, a biological sensor module connects/couples/interacts with an object **720** for a programmed drug delivery. Furthermore, an object **720** can connect/couple/interact (via one or more or all electrical/optical/radio/electro-magnetic/sensor/bio-sensor communication network(s) within and/or to and/or from an object) with an intelligent subscriber subsystem **340** and/or an intelligent appliance **880** for a location based/assisted emergency help without a human input.

An object **720** can be constructed utilizing a system-on-a-chip/a system-in-a-package/multi-chip module.

An object **720** can sense/measure/collect/aggregate/compare/map and connect/couple/interact/share (via one or more or all electrical/optical/radio/electro-magnetic/sensor/bio-sensor communication network(s) within and/or to and/or from an object) with an intelligent subscriber subsystem **340** and an intelligent appliance **880** utilizing an Internet protocol version 6 (IPv6) and its subsequent versions.

A method of securing information by an object **720**, comprising at least the following steps of: (a) sensing **900**, (b) measuring **920**, (c) collecting **940**, (d) aggregating/comparing/mapping **960**, (e) connecting/coupling/interacting/sharing **980** (in real time) with a plurality of objects **720**, intelligent subscriber subsystems **340** and intelligent appliances **880**, (f) developing a learning algorithm (e.g., a machine learning/iterative learn-by-doing/natural learning algorithm in a software module **700**) **1300** from the activities of a plurality of objects **720**, intelligent subscriber subsystems **340** and intelligent appliances **880**, (g) utilizing a learning algorithm **1320** and (h) re-iterating all the previous steps from (a) to (g) in a loop cycle **1340** to enable an intelligent decision based on information from a plurality of objects **720**, intelligent subscriber subsystems **340** and intelligent appliances **880**.

FIG. 6 illustrates a block diagram construction (configuration) of an intelligent appliance (about 125 mm long, 75 mm wide and 20 mm thick) **880**, according to another embodiment of the present invention. A processor (performance at a lower electrical power consumption is desired e.g., Graphene processor) module and a module specific software **760** is connected/coupled/interacted (via one or more or all electrical/optical/radio/electro-magnetic communication network(s) within and/or to and/or from an intelligent appliance) with one or more of the following: (a) an IP/micro IP/light weight IP address module and a module specific software **500**, (b) security module (an Internet firewall/spyware/user-specific security control/authentication) and a module specific software **520**, (c) an in-situ/remote diagnostic module and a module specific software **540**, (d) a content transfer module and a module specific software **560**, (e) a time-shift module and a module specific software **580**, (f) a place-shift module and a module specific software **600**, (g) a content (voice-video-multimedia-data) over-IP module and a module specific software **620**, (h) a radio module (with antenna(s)), wherein the radio module comprises one or more of the following modules: a RFID (active/passive), a Wibree, a Bluetooth, a Wi-Fi, an ultra-wideband, a 60-GHz/millimeter wave, a Wi-Max/4G/higher frequency radio and an indoor/outdoor position module (e.g., a Bluetooth, a Wi-Fi, a GPS and an electronic compass) and a module specific software **640**, (i) a 1-D/2-D barcode/QR-code scanner/reader module and a module specific software **660**, (j) a near-field communication (NFC) module (with an antenna) and a module specific software **680**, (k) a software module **700**, which comprises one or more of the following: an embedded/cloud based operating system software and an embedded/cloud based intelligence rendering software (e.g., a behavior modeling (www.choicestream.com), a predictive analytics/text/data/pattern mining/natural language (www.sas.com), a fuzzy logic/artificial intelligence/neural network (www.nd.com/bliaisoft.com), a machine learning/iterative learn-by-doing/natural learning (www.saffron.com) and an intelligent software agent (cougaarsoftware.com)), (l) a memory/storage module and a module specific software **780**, (m) a camera (a 180 degree rotating camera module is preferred) and a module specific software **800**, (n) a sensor module and a module specific software **820**, (o) a battery/solar cell/micro fuel-cell/wired power supply module and a module specific software **840** and (p) a display (a foldable/stretchable with a touch sensor is preferred) module and a module specific software **860**. An intelligent appliance **880** comprises a socket (e.g., SIM/SD).

Furthermore, a system-on-a-chip, integrating a processor module and a module specific software **760** with a graphic processor module, an Internet firewall, a spyware and a user-

specific security control/authentication can simplify a construction of an intelligent appliance **880**.

Furthermore, a super-capacitor (manufactured by www.cap-xx.com) and/or proton exchange membrane micro fuel-cell can enhance an operational time of a battery/solar cell/micro fuel-cell/wired power supply component.

A foldable/stretchable display component can be constructed from a graphene sheet and/or an organic light-emitting diode connecting/coupling/interacting with a printed organic transistor and a rubbery conductor (e.g., a mixture of a carbon nano-tube (CNT)/gold conductor and a rubbery polymer) with a touch/multi-touch sensor.

An intelligent appliance **880** comprises a voice-to-text-to-voice processing module and a module specific software. (e.g., Crisp Sound is a real time audio signal processing software for echo cancellation, background noise reduction, speech enhancement and equalization), a video compression module and a module specific software, a photo-editing software module and a software module for automatically uploading content to a preferred remote/cloud server.

An intelligent appliance **880** can be much thinner than 20 mm, if both display and battery components are thinner.

A thinner photonic crystal display component can be constructed as follows: optically pumps different-sized photonic crystals, whereas the photonic crystals can individually emit blue, green and red light based on their inherent sizes. An optical pump can be generated from an optical emission by an electrical activation of semiconductor quantum-wells. Blue, green and red light can be multiplexed/combined to generate a white light.

A thinner organic battery component can be constructed as follows: an organic battery utilizes push-pull organic molecules, wherein after an electron transfer process, two positively charged molecules are formed which are repelled by each other like magnets. By installing a molecular switch an electron transfer process can proceed in an opposite direction. Thus forward and backward switching of an electron flow can form a basis of an ultra-thin, light weight and power efficient organic battery.

An intelligent appliance **880** can be integrated with a miniature surround sound (e.g., a micro-electrical-mechanical-systems (MEMS) based silicon microphone component-Analog ADMP **401**/an equivalent component from www.akustica.com) module and a module specific software, a miniature power efficient projection (e.g., a holographic/micro-mirror projector) module and a module specific software, an infrared transceiver module and a module specific software and a biometric sensor (e.g., a finger-print/retinal-scan) module and a module specific software.

A projection module can be miniaturized by utilizing one tilt-able one mm diameter single crystal mirror. The mirror deflects a laser (blue, green and red) beam by rapidly switching its angle of orientation, building up a picture pixel by pixel.

An array of (at least four) front-facing cameras can provide stereo views and motion parallax (apparent difference in a direction of movement produced relative to its environment). Each camera can create a low dynamic range depth map. However, an array of cameras can create a high dynamic range depth map-thus an intelligent appliance **880** can enable a 3-D video conference.

An intelligent appliance **880** has multiple radio modules with multiple antennas. These multiple radio modules with multiple antennas can be simplified by a software-defined radio.

An augmented reality allows a computer-generated content to be superimposed over a live camera-view in a real

world. An intelligent appliance **880** can be integrated with an augmented reality to enrich a user's experience and need.

An intelligent appliance **880** can acquire information on a barcode/RFID/near-field communication (NFC) tag on a product by utilizing its radio module. An intelligent appliance **880** is aware of its location via its indoor/outdoor position module (within a radio module and a module specific software **640**) and it can search for a price/distribution location. Thus, an intelligent appliance **880** can enable a real-world physical search.

An intelligent appliance **880** that it can enable content over-IP (e.g., Skype service) via an ambient Wi-Fi/Wi-Max network, thus disrupting a traditional carrier controlled cellular business model.

Near-field communication (NFC) has a short range of about 35 mm-making it an ideal choice for a contact-less (proximity) application. Near-field communication (NFC) module (with an antenna) and a module specific software **680** can allow a user to learn/exchange/transfer/share/transact in a contact-less (proximity) application in real time. A standalone near-field communication (NFC) enabled micro-subsystem (e.g., a SD/SIM card form factor) can integrate an IP/micro IP/light weight IP address module and a module specific software **500**, a storage/memory module and a module specific software **780**, a near-field communication (NFC) module (with an antenna) and a module specific software **680** and a software module **700**. To exchange/transfer/share/transact content, a radio module and a module specific software **640** can be integrated with a standalone near-field communication (NFC) enabled micro-subsystem. To enhance the security of a standalone near-field communication (NFC) enabled micro-subsystem, a sensor module (e.g., a 0.2 mm thick finger-print sensor component (manufactured by Seiko Epson) reads an electric current on a user's finger-tip contact or a sensor component uniquely synchronized with another sensor component) and a module specific software **820** can be integrated. Furthermore, an advanced biometric (finger-print) sensor module can be constructed by combining a silica colloidal crystal with a rubber, wherein the silica colloidal crystal can be dissolved in dilute hydrofluoric (HF) acid-leaving air voids in a rubber, thus creating an elastic photonic crystal. An elastic photonic crystal emits an intrinsic color, displaying 3-D shapes of ridges, valley and pores of a finger-print, when pressed onto. A processor module and a module specific software **760** can be utilized to compare with a user's captured/stored finger-print data. A non-matching finger-print data would render a standalone micro-subsystem unusable in an abuse/fraud/theft.

Five critical contact-less (proximity) applications are: (a) Product/service discovery/initiation, (b) peer-to-peer exchange/transfer/share/transaction (c) machine-to-machine exchange/transfer/share/transaction and (d) remote access of an appliance/subsystem/system/terminal and (e) access authentication.

#### Product/Service Discovery/Initiations

A standalone near-field communication (NFC) enabled micro-subsystem, in contact-less proximity of another near-field communication (NFC) enabled appliance/subsystem/system/terminal, receives an URL (web site) to (a) provide an information about a product/service, (b) receive a direct and/or peer-to-peer marketing (e.g., a coupon/advertisement/promotion/brand loyalty program) and (c) monitor/measure an effectiveness of a marketing campaign.

#### Peer-to-Peer Exchange/Transfer/Share/Transaction

A user can share a social network/business profile/micro-loan/micro-content in contact-less proximity of a near-field communication (NFC) enabled appliance/subsystem/system/terminal of another user.

#### Machine-to-Machine Exchange/Transfer/Share/Transaction

A user can transact money/micro-loan/micro-content in contact-less proximity of a near-field communication (NFC) enabled appliance/subsystem/system/terminal.

10 An example, a standalone near-field communication (NFC) enabled micro-subsystem can enable printing a stored photo, in contact-less proximity of a near-field communication (NFC) enabled printer and displaying a stored movie, in contact-less proximity of a near-field communication (NFC) enabled TV.

15 A near-field communication (NFC) enabled TV can be constructed similarly to an intelligent appliance **880**.

Another example, a standalone near-field communication (NFC) enabled micro-subsystem can enable purchasing a travel ticket, in contact-less proximity of a near-field communication (NFC) enabled ticket appliance/subsystem/system/terminal. Such a ticket can be verified and/or located by an indoor position module without a need of a human input.

Another example, a near-field communication (NFC) enabled a printer module integrated with an electro-mechanical weighing module, an electro-mechanical postage dispensing module and a software module for calculating the postage price based on weight, distance, priority level and delivery method, can enable purchasing postage efficiently.

#### 30 Remote (Appliance/Subsystem/System/Terminal) Access

A user's profile, bookmark, address book, preference, setting, application and content of appliance/subsystem/system/terminal could be stored securely in a standalone near-field communication (NFC) enabled micro-subsystem, in contact-less proximity of a near field communication (NFC) enabled appliance/subsystem/system/terminal, it will load an original version of a user's profile, bookmark, address book, preference, setting, application and content.

#### Access Authentication

40 A user can utilize a standalone near-field communication (NFC) enabled micro-subsystem, in contact-less proximity of a near-field communication (NFC) enabled appliance/subsystem/system/terminal to enable authentication of an appliance/subsystem/system/terminal.

45 A standalone near-field communication (NFC) enabled micro-subsystem (as discussed above) can be integrated (by inserting into an electro-mechanical socket) with an intelligent appliance **880**.

A direct marketing (e.g., a coupon/advertisement/promotion/brand loyalty program) exists via AdMob and Groupon. A static social network also exists via MySpace and Facebook. The primary motivation of a user is social connections with other users in a social network website. However, a web based social network can limit a human bond.

55 A standalone near-field communication (NFC) enabled micro-subsystem/intelligent appliance can enable an off-line social exchange and direct and/or a peer-to-peer marketing.

A personalized social network can utilize an augmented identity (e.g., Recognizr) in addition to a profile. A personalized social network can keep track of an information/discussion/interest, which are important to a user/users and makes such an information/discussion/interest available to a user/users when a user/users is either on-line and/off-line.

65 A direct marketing can be segmented by demographics/geographical locations (e.g., a gender/marital status/age/religion/interest/education/work-position/income/credit profile/net asset/zip code). However, adding real time geographical

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location to direct marketing can be useful (e.g., a user close to a stadium and minutes before an event, can purchase a ticket and after an event can receive direct marketing campaign based on a user's interests/preferences/patterns. This is a personalized marketing)

Personalization can be enhanced by an intelligence rendering software module (e.g., a machine learning/iterative learning-by-doing/natural learning algorithm in a software module 700). An intelligent software agent (a do-engine) can search an Internet automatically and recommend a user about a product/service/content based on a user's interests/preferences/patterns. An integration of a user social network profile, a user's interests/preferences/patterns, a user's real time geographical location, data/information/images from objects 720 and an interaction (of an object 720 with an intelligent subscriber subsystem 340 and an intelligent appliance 880) collectively can embed physical reality into an Internet space and an Internet reality into a physical space-thus it can enrich a user's experience and need.

FIG. 7 illustrates a block diagram method flow-chart (configuration) enabling an intelligent, location based and personalized social network can be realized by comprising at least the following steps of: (a) authenticating a user 1000, (b) understanding a user's profile (an augmented identity is preferred) 1020, (c) remembering a user's need 1040, (d) remembering a user's conversation 1060, (e) reminding a user's need 1080, (f) determining a user's location (real time is preferred) 1100, (g) searching an Internet for a user's need (an intelligent software agent is preferred) 1120, (h) recommending a product/service best suited for a user's need 1140, (i) developing a learning algorithm (e.g., a machine learning/iterative learning-by-doing/natural learning algorithm in a software module 700) 1300 from a plurality of users' activities, (j) utilizing a learning algorithm 1320 and (k) re-iterating all previous steps from (a) to (j) in a loop cycle 1340.

FIG. 8 illustrates a block diagram method flow-chart (configuration) enabling an intelligent, location based and personalized direct marketing (e.g., a coupon/advertisement/promotion/brand loyalty program) by comprising at least the following steps of (a) authenticating a user 1000, (b) understanding a user's profile (an augmented identity is preferred) 1020, (c) remembering a user's need 1040, (d) remembering a user's conversation 1060, (e) reminding a user's need 1080, (f) determining a user's location (real time is preferred) 1100, (g) searching an Internet for a user's need (an intelligent software agent is preferred) 1120, (h) delivering a direct marketing material (e.g., a coupon/advertisement/promotion/brand loyalty program) based on a user's need 1160, (i) developing a learning algorithm (e.g., a machine learning/iterative learning-by-doing/natural learning algorithm in a software module 700) 1300 from a plurality of users' activities, (j) utilizing a learning algorithm 1320 and (k) re-iterating all previous steps from (a) to (j) in a loop cycle 1340.

A method of enabling an intelligent, location based and personalized peer-to-peer marketing (e.g., a coupon/advertisement/promotion/brand loyalty program) can be realized by comprising at least the steps of: (a) authenticating a user 1000, (b) understanding a first user's profile (an augmented identity is preferred) 1020, (c) authenticating a second user 1000A, (d) understanding a second user's profile (an augmented identity is preferred) 1020A, (e) determining a first user's location (real time is preferred) 1100, (f) determining a second user's location (real time is preferred) 1100A, (g) communicating and/or sharing with a plurality of users for a collective need (an augmented identity is preferred) 1180, (h) determining users' locations (real time is preferred) 1100B, (i) delivering a marketing material (e.g., a coupon/advertise-

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ment/promotion/brand loyalty program) from a first user to a second user and/or users, seeking a marketing material (e.g., a coupon/advertisement/promotion/brand loyalty program) 1160A, (j) developing a learning algorithm (e.g., a machine learning/iterative learning-by-doing/natural learning algorithm in a software module 700) 1300 from a plurality of users' activities, (k) utilizing a learning algorithm 1320 and (o) re-iterating all previous steps from (a) to (k) in a loop cycle 1340.

10 A method of enabling an intelligent, location based and personalized peer-to-peer micro-loan transaction can be realized by comprising at least the steps of: (a) authenticating a user 1000, (b) understanding a first user's profile (an augmented identity is preferred) 1020, (c) authenticating a second user 1000A, (d) understanding a second user's profile (an augmented identity is preferred) 1020A, (e) determining a first user's location (real time is preferred) 1100, (f) determining a second user's location (real time is preferred) 1100A, (g) communicating and/or sharing with a plurality of users for a collective need (an augmented identity is preferred) 1180, (h) determining users' locations (real time is preferred) 1100B, (i) determining legal parameters of a micro-loan 1200, (j) agreeing on legal parameters of a micro-loan 1220, (k) establishing a security protocol between a first user and a second user and/or users, seeking a micro-loan 1240, (l) delivering a micro-loan from a first user to a second user and/or users, seeking a micro-loan 1160B, (m) developing a learning algorithm (e.g., a machine learning/iterative learning-by-doing/natural learning in a software module 700) 1300 from a plurality of users' activities, (n) utilizing a learning algorithm 1320 and (o) re-iterating all previous steps from (a) to (n) in a loop cycle 1340.

A method of enabling an intelligent, location based and personalized peer-to-peer micro-content transaction can be realized by comprising at least the steps of (a) authenticating a user 1000, (b) understanding a first user's profile (an augmented identity is preferred) 1020, (c) authenticating a second user 1000A, (d) understanding a second user's profile (an augmented identity is preferred) 1020A, (e) determining a first user's location (real time is preferred) 1100, (f) determining a second user's location (real time is preferred) 1100A, (g) communicating and/or sharing with a plurality of users for a collective need (an augmented identity is preferred) 1080, (h) determining users' locations (real time is preferred) 1100B, (i) determining legal parameters of a micro-content transfer 1200 (j) agreeing on legal parameters of a micro-content transfer 1220, (k) establishing a security protocol between a first user and a second user and/or users, seeking a micro-content transfer 1240, (l) delivering a micro-content from a first user to a second user and/or users, seeking a micro-content 1160C, (m) developing a learning algorithm (e.g., a machine learning/iterative learning-by-doing/natural learning algorithm in a software module 700) 1300 from a plurality of users' activities, (n) utilizing a learning algorithm 1320 and (o) re-iterating all previous steps from (a) to (n) in a loop cycle 1340.

FIG. 9 illustrates a block diagram method flow-chart (configuration) enabling an intelligent, location based and personalized secure contact-less (proximity) Internet access authentication can be realized by comprising at least the steps of: (a) authenticating a user 1000, (b) determining a first user's location (real time is preferred) 1100, (b) coming in proximity of a near-field enabled appliance/subsystem/system/terminal 1260, (c) authenticating the user for an Internet 1280, (d) developing a learning algorithm (e.g., a machine learning/iterative learning-by-doing/natural learning algorithm in a software module 700) 1300 from a plurality of users' activi-

ties, (e) utilizing a learning algorithm 1320 and (f) re-iterating all previous steps from (a) to (e) in a loop cycle 1340.

An intelligent software agent can also search an Internet automatically and recommend a user about a product/service/content based on a user's interests/preferences/patterns. An intelligence rendering software algorithm in a software module 700, allows an intelligent subscriber subsystem 340 and an intelligent appliance 880 to adapt/learn/relearn a user's interests/preferences/patterns and thereby rendering intelligence.

For example, a bedroom clock connects/couples/interacts with an intelligent subscriber subsystem 340 and/or an intelligent appliance 880, to automatically check on a traffic pattern/flight schedule via an Internet, before deciding whether to fiddle with an alarm time without a human input. A rechargeable toothbrush detects a cavity in the teeth, it sends a signal through its electrical wiring and connects/couples/interacts with an intelligent subscriber subsystem 340 and/or an intelligent appliance 880, automatically accesses a location based/assisted dentist's electronic appointment book for a consultation without a human input.

An intelligent appliance 880, can integrate a chemical/biological sensor module (e.g., to monitor/measure a body temperature, % oxygen, a heart rhythm, a blood glucose concentration, a carbonyl sulfide gas emission due to a liver/lung disease and a bio-marker for a disease parameter) with a module specific software.

A Zinc Oxide nano-structure can detect many toxic chemicals. Also a quantum cascade DFB/DBR/DR laser (with an emission wavelength in mid-to-far infrared range) can detect a part per billion amount of carbonyl sulfide gas. A wavelength switching of a quantum cascade DFB/DBR/DR laser can be achieved by temperature, utilizing a thin-film resistor/heater, while electrically insulating a laser bias current electrode. Wavelength switching by temperature is a slow (about ten milliseconds) thermal process. However, wavelength switching by electrical currents on multiple segments of a quantum cascade DFB/DBR/DR laser is a rapid (about one millisecond) process. A larger wavelength tuning range (nm) can be achieved by an array (a monolithic array is preferred) of multi-segment quantum cascade DFB/DBR/DR lasers. Furthermore, a quantum cascade DFB/DBR/DR laser can emit in terahertz wavelength (85  $\mu\text{m}$  to 150  $\mu\text{m}$ ) range, where a metal has a high reflectivity. Thus a quantum cascade DFB/DBR/DR laser is ideal for a metal detection (security).

A compact bio-marker-on-a-chip to monitor/measure a disease parameter can be constructed by analyzing a change in reflectance and/or a Raman shift and/or surface electric current due to a disease-related bio-marker presence (with a specific antibody at about a picogram per mL concentration) on a surface of a 2-D/3-D photonic crystal of dielectric material. Confirmation of a bio-marker is not conclusive for an onset/presence of a disease. Identifications of many bio-markers are necessary to predict an onset/presence of a disease. However, a 2-D/3-D photonic crystal of dielectric material, incident with a multi-wavelength (blue, green and red) light source can be utilized for simultaneous identifications of many bio-markers of a disease. A multi-wavelength (blue, green and red) light source can be constructed as follows: optically pumps different-sized photonic crystals, whereas the photonic crystals can individually emit blue, green and red light based on their inherent sizes. An optical pump can be generated from an optical emission by an electrical activation of semiconductor quantum-wells. Blue, green and red light can be multiplexed/combined to generate a white light. A Raman shift, scattered by a bio-marker requires an expensive high-performance laser. However, a Raman sensor (requires

an inexpensive CD-laser and a wavelength tunable filter) can monitor/measure a Raman shift due to a disease-related bio-marker presence. A bio-marker molecule can induce a change in surface induced electric current when it binds to an atomically thin graphene surface (graphene's electronic sensitivity to biomolecular adsorption).

Furthermore, an array of graphene bio-sensors can detect many bio-markers of a disease-thus enabling a personalized ultra-compact diagnostic module, which can be connected/coupled/interacted with an intelligent subscriber subsystem 340 and an intelligent appliance 880.

A biological lab-on-a-chip (LOC) is a module that integrates a few bio-analytical functions on a single chip to perform a point-of-care disease diagnostics. A miniature biological lab-on-a-chip (LOC) module manufactured by Ostendum ([www.ostendum.com](http://www.ostendum.com)) can be integrated (by inserting into an electro-mechanical cavity) with an intelligent appliance 880 to perform a point-of-care disease diagnostics reliably, quickly and economically. Such a lab result can be transmitted from an intelligent appliance 880 to a location based/assisted physician for an interpretation without a human input. Furthermore, powered by a nano-generator, Zinc Oxide nano-wire fabricated on Gallium Nitride/Indium Gallium Nitride/Aluminum Gallium Nitride can be a nano-light source (nano-LED) for a biological lab-on-a-chip.

Holographic images of a user's gene/protein can be stored in an intelligent appliance 880-thus a holographic image can enable a physician/surgeon to design a personalized medical and/or a surgical treatment.

Many software modules, as discussed above can consume a significant electrical power due to computational complexities. Alternatively, many software modules can be processed at a secure remote/cloud server. Software modules can be embedded within an intelligent subscriber subsystem 340 and/or an intelligent appliance 880, if an electrical power consumption and/or thermal management are feasible. An effective thermal management is critical to construct a high-performance intelligent appliance 880. Thermal resistance must be minimized at all material interfaces and materials with closely matching thermal expansion coefficients must be used.

Graphene can be viewed as a plane of carbon atoms extracted from a graphite crystal. Multiple-atomic layers of graphene are easier to fabricate than a single-atomic layer graphene and multiple-atomic layers of graphene retain thermal conductivity of a single-atomic layer graphene. Nano-scaled graphene heat pipe can be utilized to cool a hot spot within an intelligent appliance 880. For efficient thermal management, a heat sink/heat spreader of graphene/diamond/aluminum nitride/copper/aluminum/silicon/material with closely matching thermal expansion coefficients can be attached (e.g., to a processor module 760) by utilizing an interface heat transfer material (e.g., Indigo™ [www.enerdynesolutions.com](http://www.enerdynesolutions.com)). However, a significant (about ten times) heat transfer of a heat sink/heat spreader can be gained by creating a nano-structured (e.g., Zinc Oxide nano-structures fabricated by micro-reactor assisted nano-material deposition process) surface on a heat sink/heat spreader. Furthermore, micro-channels can be fabricated by a laser machining method onto a heat sink/heat spreader for passive air and/or active (air/liquid/micro-scale ion cloud) cooling.

A micro-scale ion cloud can be generated as follows: on one side of graphene based micro-channels is a carbon nanotube (CNT) negative electrode, when a negative voltage is switched on, electrons jump from a negative electrode toward a positive electrode, colliding with air molecules near a hot spot thus dissipating heat and producing a micro-scale cloud

of positively charge ions. A micro-scale cloud of positively charge ions drifts towards a present negative electrode. However, before it reaches to present negative electrode, a voltage is switched on to another negative electrode at a different position. Forward and reverse wind of a micro-scale cloud of positively charge ions (created by changing the positions of negative electrodes) can cool a hot spot within an intelligent appliance **880**. Alternatively, a high-efficiency nano-structured 50 Å thick Sb<sub>2</sub>Te<sub>3</sub>/10 Å thick Bi<sub>2</sub>Te<sub>3</sub>-based thin-film super-lattices thermoelectric cooler (TEC)/micro-refrigerator (1 mm×3 mm) can also be utilized to cool a hot spot within an intelligent appliance **880**. However, significant thermoelectric cooler (TEC)/micro-refrigerator efficiency can be gained by fabricating a quantum wire/quantum dot, transitioning from a two-dimensional super-lattice.

Furthermore an intelligent appliance **880** can be charged via a resonant electro-magnetic inductive coupling energy transfer (within and/or to and/or from) without a physical wire.

The aluminum/magnesium alloys have small building blocks-called nano-crystal grains and crystal defects. Nano-crystal grains with crystal defects are mechanically stronger than perfect aluminum/magnesium crystals. An intelligent appliance **880**'s outer package can be constructed from a nano-engineered aluminum/magnesium alloy, a liquid Metal® alloy (www.liquidmetal.com), carbon-polymer composite (carbon fiber embedded with a molten polymer injection mold) and magnesium metal. Furthermore, an antenna can be constructed from a carbon fiber embedded with a metal/conducting polymer.

FIG. **10** illustrates a block diagram construction (configuration) of connections/couplings/interactions (via one or more or all electrical/optical/radio/sensor/bio-sensor communication network(s)) between an object(s) **720** with an intelligent subscriber subsystem(s) **340** and an intelligent appliance(s) **880**, utilizing an Internet protocol version 6 (IPv6) and its subsequent versions. The context-awareness is (according to a user's situational context), personalized (tailored to a user's need), adaptive (change in response to a user's need) and anticipatory (can anticipate a user's desire).

An intelligent subscriber subsystem **340** and an intelligent appliance **880** are both context-ware (inferred from a user's past/present activities, extracted from a user's content/data and explicit in a user's profile) and sensor-aware (inferred from data/image/patterns from an object(s)).

FIG. **11** illustrates a block diagram method flow-chart (configuration) enabling a task execution by a software agent. An incoming task is communicated from a communication channel **1360**, to an incoming queuing element **1380**, to an execution manager **1400**. An execution manager **1400** gains information from (and also shares with) a transient knowledge element **1420** and a data base element **1600**. An execution manager **1400** further gains information from a permanent knowledge element **1440**, which comprises an attribute element **1460** and a capability element **1480**. A capability element **1480** is connected to a task element **1500**, which is further connected to a rule element **1520**, a method element **1540** and a knowledge source element **1560**. Executed/processed task from an execution manager **1400**, is communicated to an outgoing queuing task controller **1580** to a communication channel **1360**.

The above description is provided to illustrate only preferred embodiments of the present invention, however it is not intended to be limiting. Numerous variations and modifications within the scope of the present invention are possible.

I claim:

1. An optical system, comprising:

- (a) a node configured with a remote node comprising: at least one single-mode optical fiber;
- (b) the node configured with the remote node comprising: at least one optical subsystem, wherein the optical subsystem is selected from the group consisting of: a wavelength division multiplexer, a wavelength division demultiplexer and a cyclic arrayed waveguide grating router;
- (c) the node further comprising: a first optical subsystem and a second optical subsystem, wherein the first optical subsystem is configured for transmission of more than one gigabit per second of optical signals, wherein the optical signals are selected from one or more wavelengths of a first set of wavelengths, wherein the second optical subsystem is configured for reception of at least one gigabit per second of optical signals, wherein the optical signals are selected from one or more wavelengths of a second set of wavelengths, which are offsets in wavelengths with respect to the first set of wavelengths;
- (d) the remote node comprising: a subscriber optical subsystem, wherein the subscriber optical subsystem is configured for reception of more than one gigabit per second of optical signals, wherein the optical signals are selected from one or more wavelengths of the first set of wavelengths, wherein the subscriber optical subsystem is further configured for transmission of at least one gigabit per second of optical signals, wherein the optical signals are selected from one or more wavelengths of the second set of wavelengths, which are offset in wavelengths with respect to the first set of wavelengths,
- wherein the transmission of optical signals is configured by an optical micro-subsystem in a looped arrangement at the subscriber optical subsystem, wherein the optical micro-subsystem is configured for phase modulation, intensity modulation and amplification of optical signals.

2. The optical system according to claim 1, wherein the optical system further comprises a local node.

3. The optical system according to claim 1, wherein the node further comprises a local node.

4. The optical system according to claim 1, wherein the optical system further comprises a transmission protocol, wherein the transmission protocol is selected from the group consisting of: a time division multiplexing and a broadcast.

5. The optical system according to claim 1, wherein the optical system further comprises a reception protocol, wherein the reception protocol is selected from the group consisting of: a time division multiplexing and a broadcast.

6. The optical system according to claim 1, wherein the optical system further comprises an electronic circuit module, wherein the electronic circuit module is selected from the group consisting of: a pilot-tone modulation circuit, a burst-mode circuit, a forward-error correction circuit and an electronic dispersion compensation circuit.

7. The optical system according to claim 1, wherein the optical system further comprises an optical module, wherein the optical module is selected from the group consisting of: a laser, a photodiode, a modulator, a demodulator, a phase-to-intensity converter, an optical amplifier, an optical power combiner, an optical power decoupler, a wavelength combiner, a wavelength decombining, an arrayed waveguide grating router, a cyclic arrayed waveguide grating router, a space switch, an optical switch, an optical circulator, an optical

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filter, an optical intensity attenuator and a dispersion-compensated single-mode optical fiber.

8. The optical system according to claim 1, wherein the subscriber optical subsystem further comprises an optical amplifier module and an optical module, wherein the optical module is selected from the group consisting of: a laser, a phase modulator, an intensity modulator and an optical intensity attenuator.

9. The optical system according to claim 1, wherein the subscriber optical subsystem further comprises a photodiode module, an optical circulator and an optical filter.

10. The optical system according to claim 1, wherein the subscriber optical subsystem further comprises an internet address, an internet firewall, a spyware and an algorithm, wherein the algorithm is selected from the group consisting of:

a user specified safety control algorithm, an in situ in situ diagnostics algorithm, a remote diagnostics algorithm and an authentication algorithm.

11. The optical system according to claim 1, wherein the subscriber optical subsystem further comprises a connection module, wherein the connection module is selected from the group consisting of: an electrical wire, a radio module, an electro-magnetic induction module and a sensor module.

12. The optical system according to claim 11, wherein the radio module is selected from the group consisting of: an ultra-wideband module, a millimeter wave module, a software-defined radio module and a position module.

13. The optical system according to claim 12, wherein the position module is selected from the group consisting of: a Bluetooth module, a Wi-Fi module, a GPS module and an electronic compass module.

14. The optical system according to claim 1, wherein the subscriber optical subsystem further comprises an electronic module, wherein the electronic module is selected from the group consisting of: a voice processing module, a video compression module, a content over-IP module, a video conference over-IP module, a 3D video conference over-IP module, a voice-to-text module and a text-to-voice module.

15. The optical system according to claim 1, wherein the subscriber optical subsystem further comprises an algorithm, wherein the algorithm is selected from the group consisting of: a voice processing algorithm, a video compression algorithm, a content over-IP algorithm, a video conference over-IP algorithm, a 3D video conference over-IP algorithm, a voice-to-text algorithm and a text-to-voice algorithm.

16. The optical system according to claim 1, wherein the subscriber optical subsystem further comprises an electronic module, wherein the electronic module is selected from the group consisting of: a set top box, an internet connected set top box, a personal video recorder, an internet connected personal video recorder, a personal server, an internet connected personal server, a time-shift module, an internet connected time-shift module, a place-shift module and an internet connected place-shift module.

17. The optical system according to claim 1, wherein the subscriber optical subsystem further comprises an intelligence rendering algorithm.

18. The optical system according to claim 1, wherein the subscriber optical subsystem further comprises an algorithm with a software agent.

19. The optical system according to claim 1, wherein the subscriber optical system is further configured for context-awareness.

20. The optical system according to claim 1, wherein the subscriber optical subsystem is further configured for sensor-awareness.

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21. The optical system according to claim 1, wherein the subscriber optical subsystem is further configured with a connection module, wherein the connection module is selected from the group consisting of: an electrical wire, a radio module, an electro-magnetic induction module, a sensor module and a bio-sensor module for a coupling with an object, wherein the object comprises a power source module and wherein the object further comprises a module selected from the group consisting of: a sensor module, a bio-sensor module and a radio module.

22. The optical system according to claim 1, wherein the subscriber optical subsystem is further configured with a connection module, wherein the connection module is selected from the group consisting of: an electrical wire, a radio module, an electro-magnetic induction module, a sensor module and a bio-sensor module for a coupling with an appliance, wherein the appliance comprises an IP address, an operating system algorithm, a processor module, a memory module, a display module, a microphone module, a camera module, a radio module and a power source module.

23. The optical system according to claim 1, wherein the subscriber optical subsystem is further configured with connection module, wherein the connection module is selected from the group consisting of: an electrical wire, a radio module, an electro-magnetic induction module, a sensor module and a bio-sensor module for a coupling to an appliance, wherein the appliance comprises an IP address, an operating system algorithm, an intelligence rendering algorithm, a processor module, a memory module, a display module, a microphone module, a camera module, a radio module and a power source module.

24. The optical system according to claim 1, wherein the subscriber optical subsystem is further configured with connection module, wherein the connection module is selected from the group consisting of: an electrical wire, a radio module, an electro-magnetic induction module, a sensor module and a bio-sensor module for a coupling to an appliance, wherein the appliance comprises IP address, an operating system algorithm, an intelligence rendering algorithm, an algorithm with a software agent, a processor module, a memory module, a display module, a microphone module, a camera module, a radio module and a power source module.

25. An optical system, comprising:

(a) a node configured with a remote node comprising: at least one single-mode optical fiber;

(b) the node configured with the remote node comprising: at least one optical subsystem, wherein the optical subsystem is selected from the group consisting of: a wavelength division multiplexer, a wavelength division demultiplexer and a cyclic arrayed waveguide grating router;

(c) the node further comprising: a first optical subsystem and a second optical subsystem,

wherein the first optical subsystem is configured for at least one function, selected from the group consisting of: transmission of wavelength on-Demand, transmission of bandwidth on-Demand and transmission of service on-Demand, selected from one or more wavelengths of a first set of wavelengths,

wherein the transmission of wavelength on-Demand is further configured by at least one function, selected from the group consisting of: wavelength tuning, phase modulation and intensity modulation of optical signals, wherein the transmission of bandwidth on-Demand is further configured by at least one function, selected from the group consisting of: wavelength tuning, phase modulation and intensity modulation of optical signals,



wherein the transmission of service on-Demand is further configured by at least one function, selected from the group consisting of: wavelength tuning, phase modulation and intensity modulation of optical signals, and wherein the second optical subsystem is configured for reception of bandwidth, selected from one or more wavelengths of a second set of wavelengths, which are offsets in wavelengths with respect to the first set of wavelengths;

(d) the remote node comprising: a subscriber optical subsystem,

wherein the subscriber optical subsystem is configured for at least one function, selected from the group consisting of: reception of wavelength on-Demand, reception of bandwidth on-Demand and reception of service on-Demand, selected from one or more wavelengths of the first set of wavelengths,

wherein the subscriber optical subsystem is further configured for transmission of bandwidth, selected from one or more wavelengths of a second set of wavelengths, which are offsets in wavelengths with respect to the first set of wavelengths, wherein the subscriber optical subsystem is further configured for transmission of optical signals, selected from one or more wavelengths of the second set of wavelengths, which are offsets in wavelengths with respect to the first set of wavelengths,

wherein the transmission of optical signals is configured by an optical micro-subsystem in a looped arrangement at the subscriber optical subsystem, wherein the optical micro-subsystem is configured for phase modulation, intensity modulation and amplification of optical signals.

\* \* \* \* \*



US008073331B1

(12) **United States Patent**  
**Mazed**

(10) **Patent No.:** **US 8,073,331 B1**  
(45) **Date of Patent:** **Dec. 6, 2011**

(54) **DYNAMIC INTELLIGENT BIDIRECTIONAL  
OPTICAL AND WIRELESS ACCESS  
COMMUNICATION SYSTEM**

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(\*) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 935 days.

(21) Appl. No.: **11/952,001**

(22) Filed: **Dec. 6, 2007**

**Related U.S. Application Data**

(60) Provisional application No. 60/868,838, filed on Dec.  
6, 2006, provisional application No. 60/883,727, filed  
on Jan. 5, 2007, provisional application No.  
60/970,487, filed on Sep. 6, 2007.

(51) **Int. Cl.**

**H04Q 11/02** (2006.01)

**H04J 14/00** (2006.01)

**H04L 12/64** (2006.01)

**H01S 3/10** (2006.01)

**H01S 3/00** (2006.01)

(52) **U.S. Cl.** ..... **398/68; 398/66; 398/43; 398/45;**  
**398/72; 370/420; 370/467; 370/430**

(58) **Field of Classification Search** ..... **398/66,**  
**398/68, 43**

See application file for complete search history.

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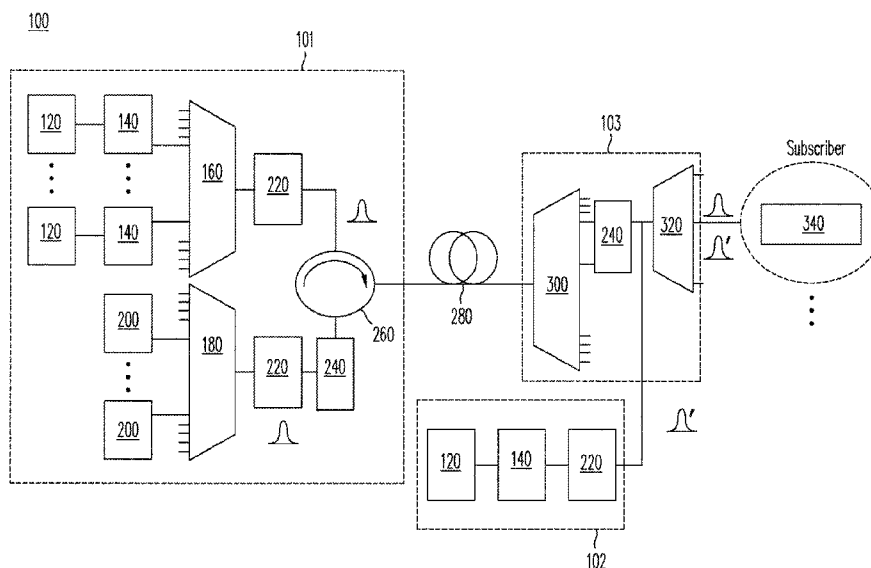
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Posey, Esq.

(57)

**ABSTRACT**

According to one embodiment of the present invention, a wavelength-shifted dynamic intelligent bidirectional access optical system utilizes key optical elements such as: a quantum dot enabled semiconductor optical amplifier, a phase modulator and an intensity modulator to provide upstream optical signals. These key optical elements reduce the Rayleigh backscattering effect on the transmission of optical signals. to enable a longer-reach access network topology between a subscriber unit and a super node (e.g., many local nodes collapsed into one super node). Such a longer-reach access network topology eliminates operational and capital costs related routers and switches. Furthermore, a wavelength to a subscriber unit may be protected and dynamically varied for on-Demand bandwidth, information and services and also a subscriber's unit may be configured with any array of connectivity options.

**37 Claims, 8 Drawing Sheets**



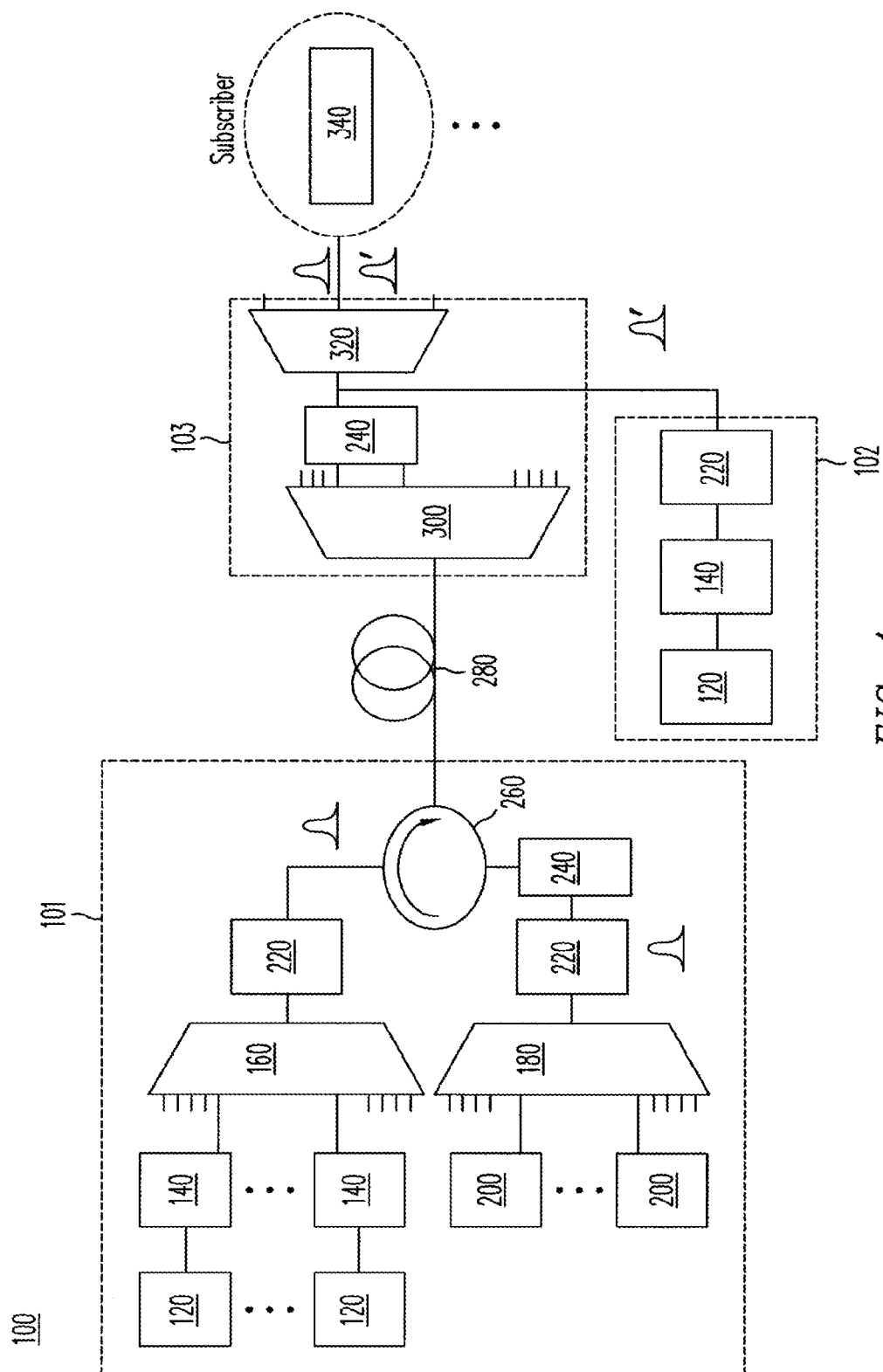


FIG. 1

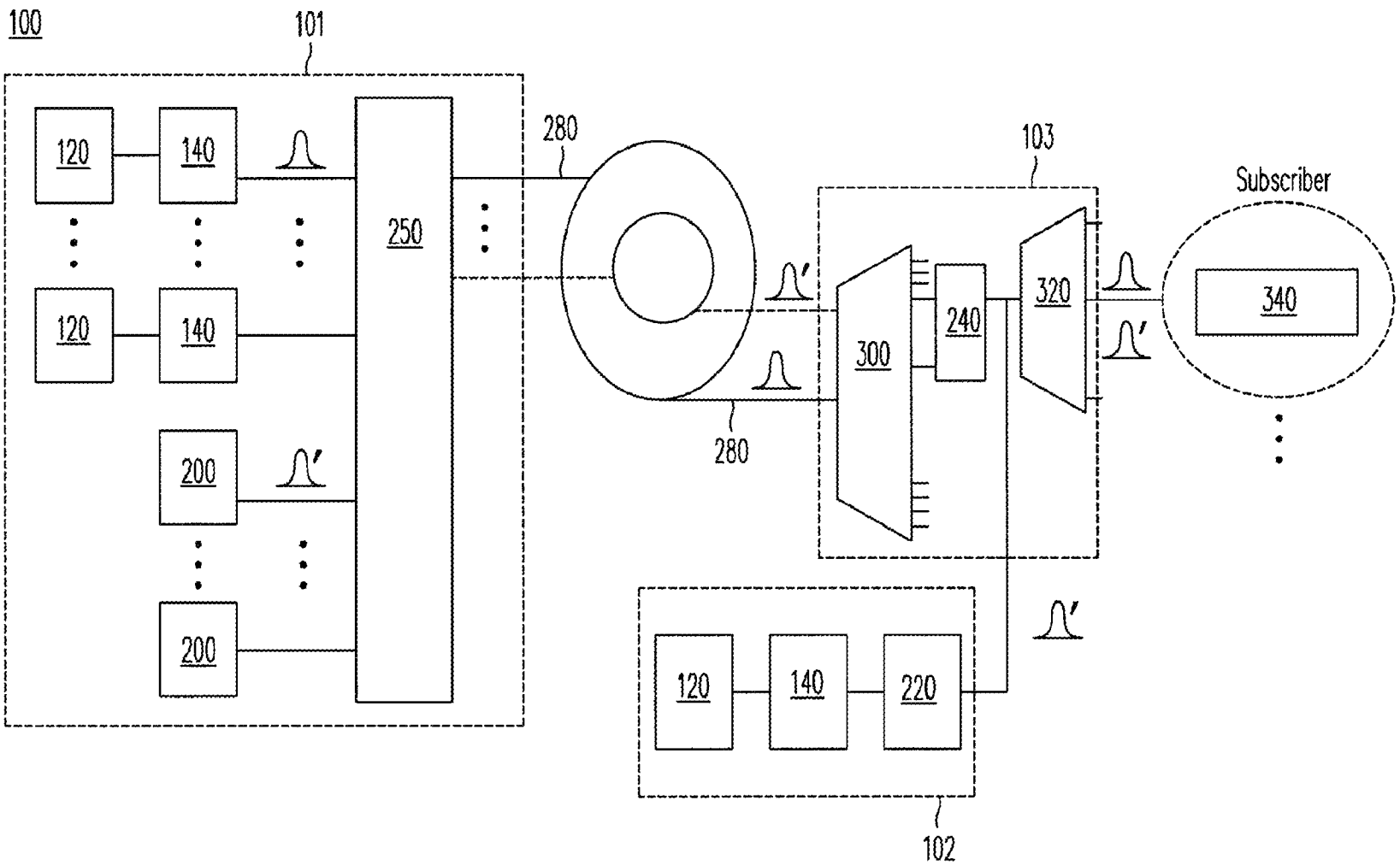


FIG. 2

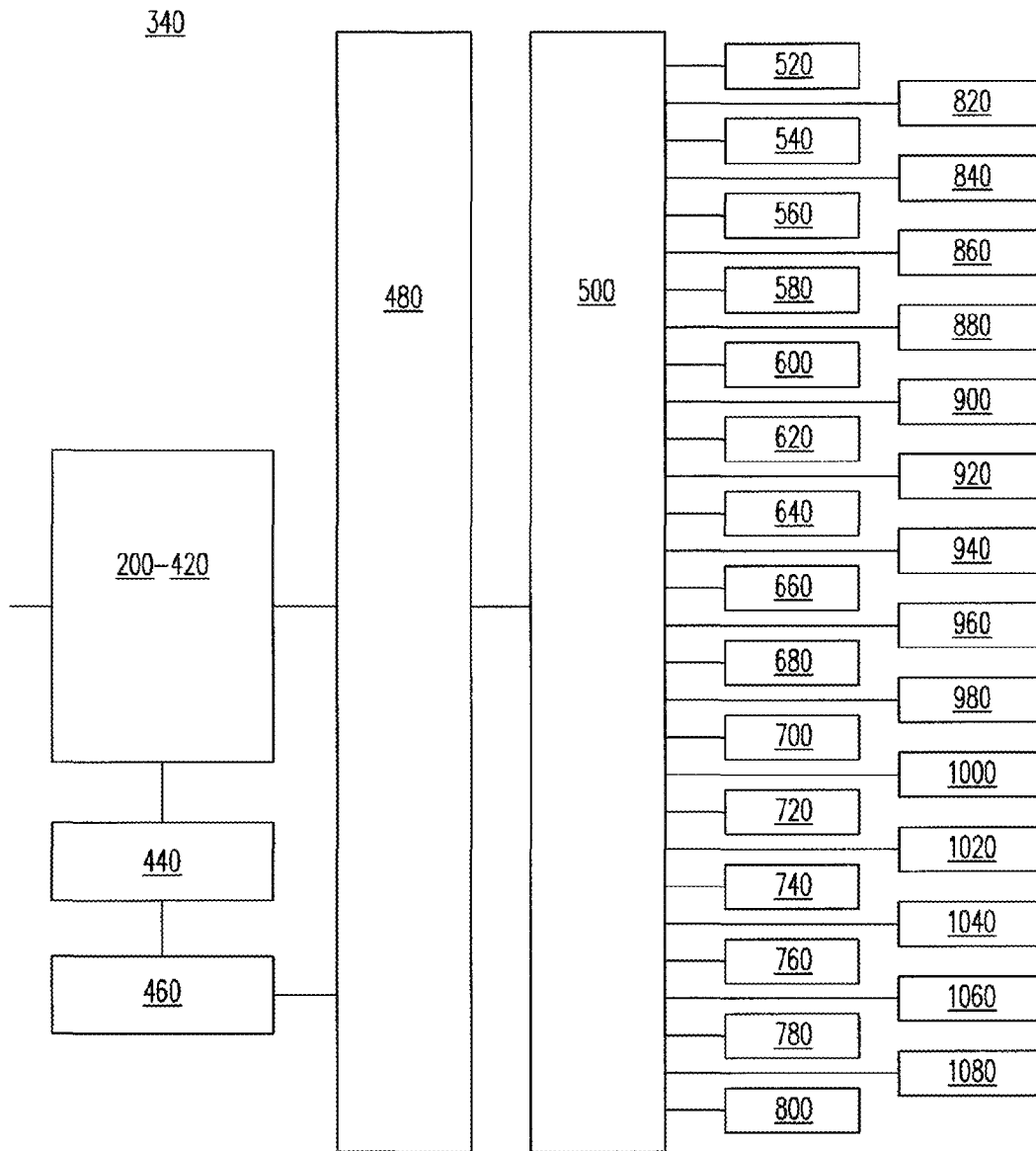


FIG. 3A

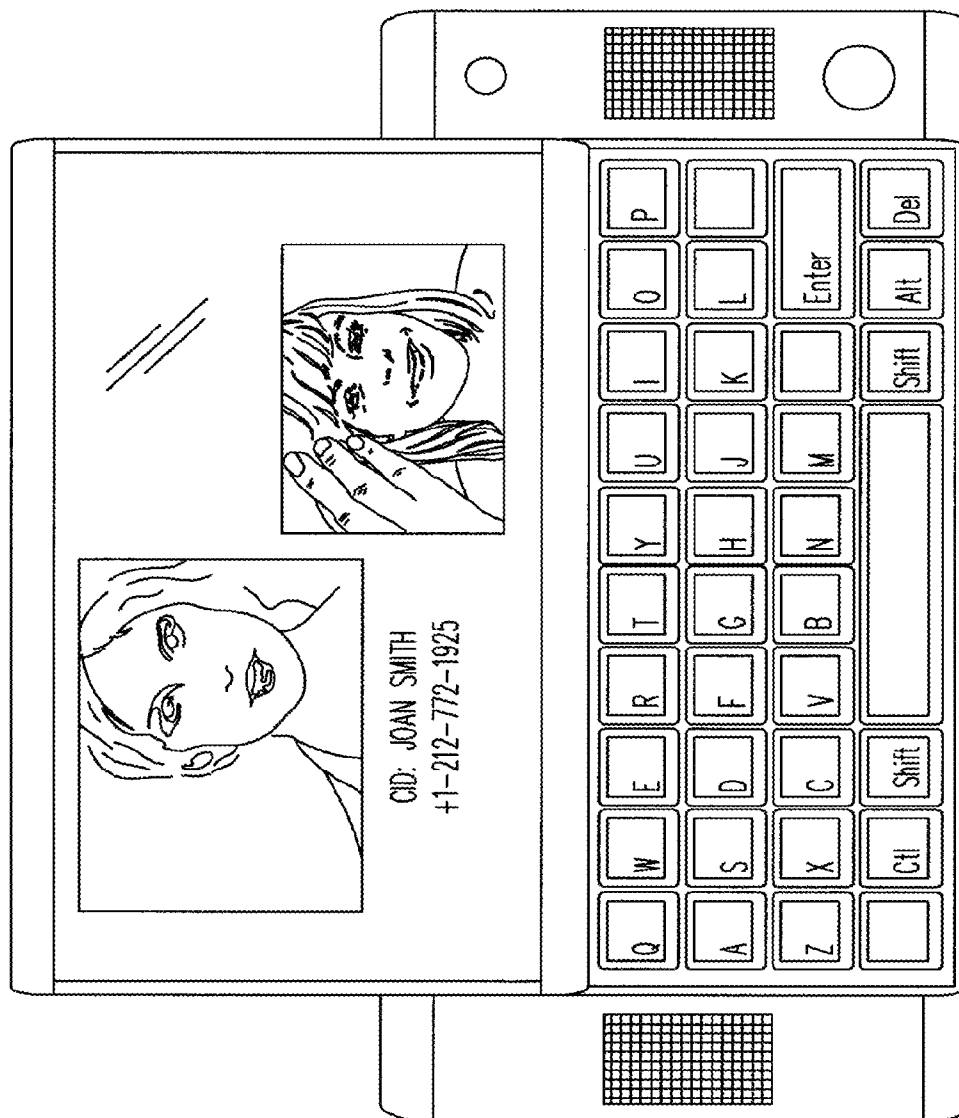


FIG. 3B

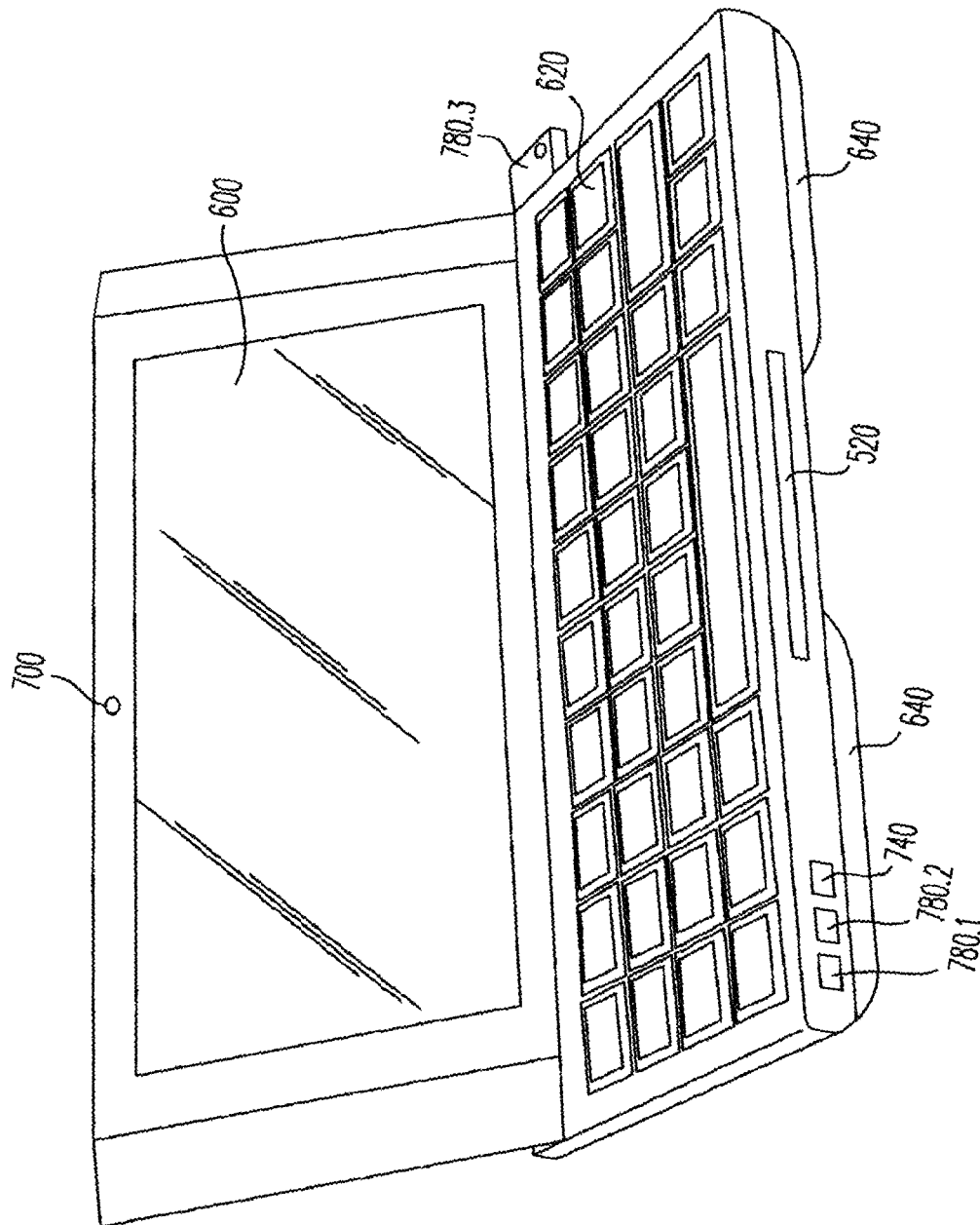


FIG. 3C

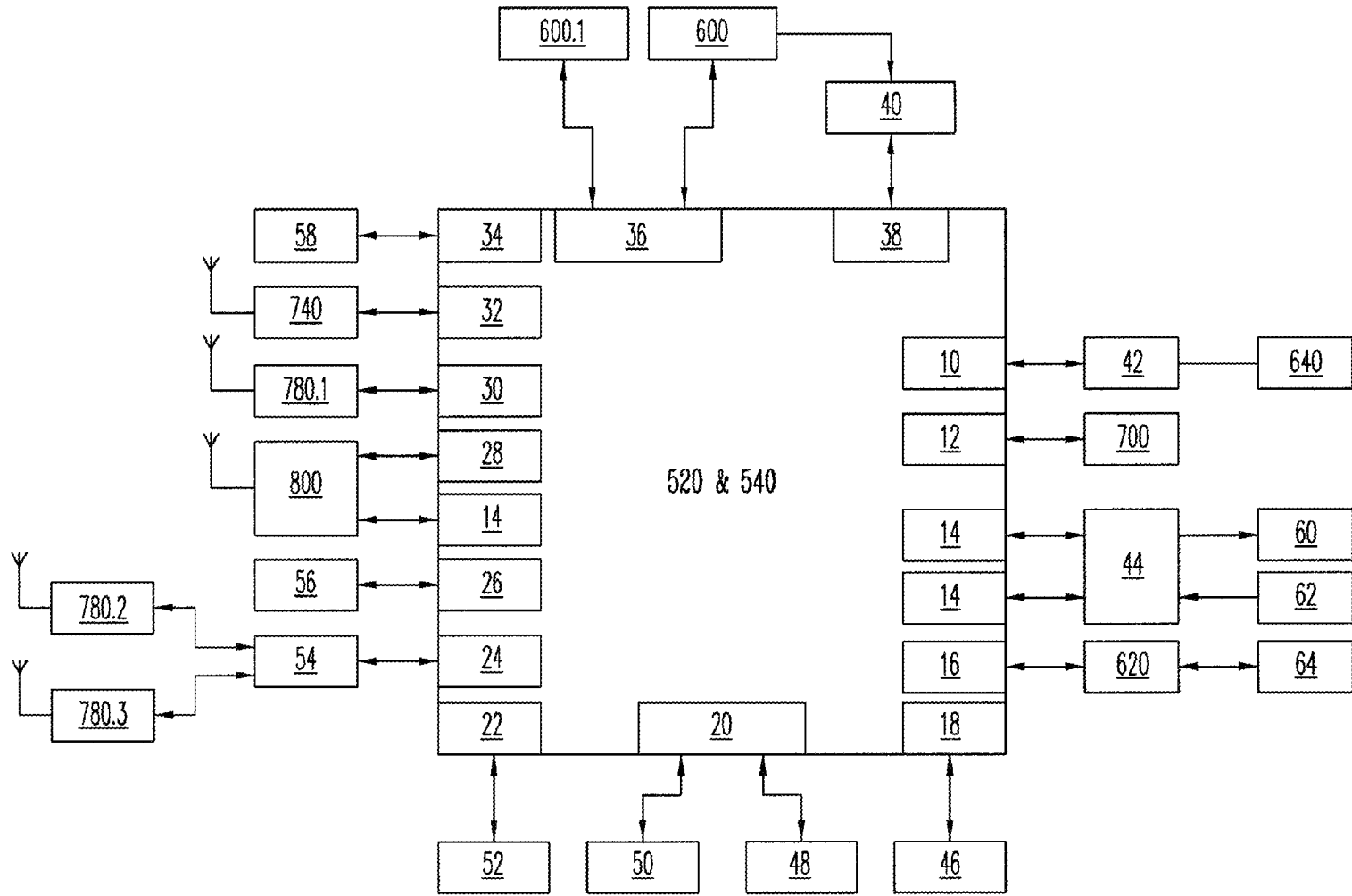


FIG. 3D



200-420

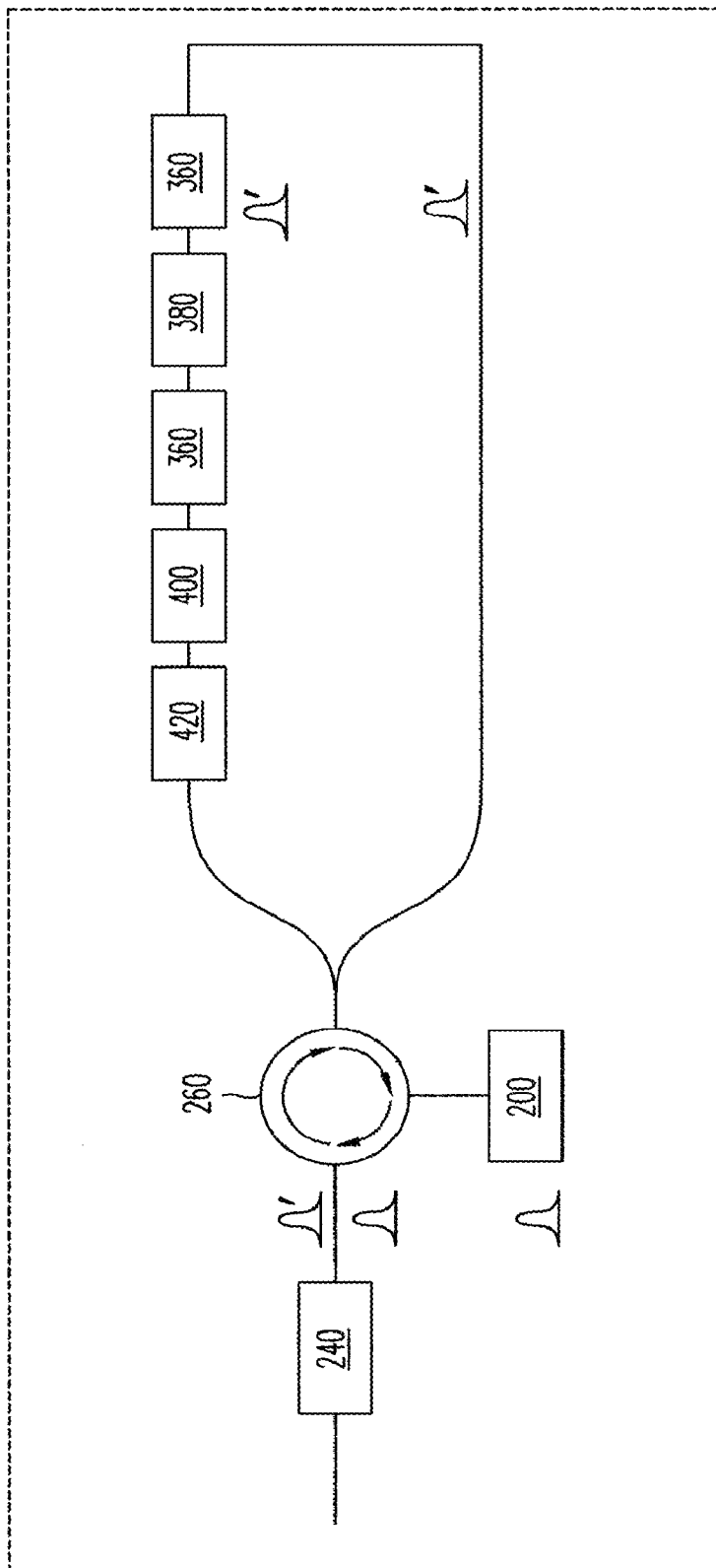


FIG. 4

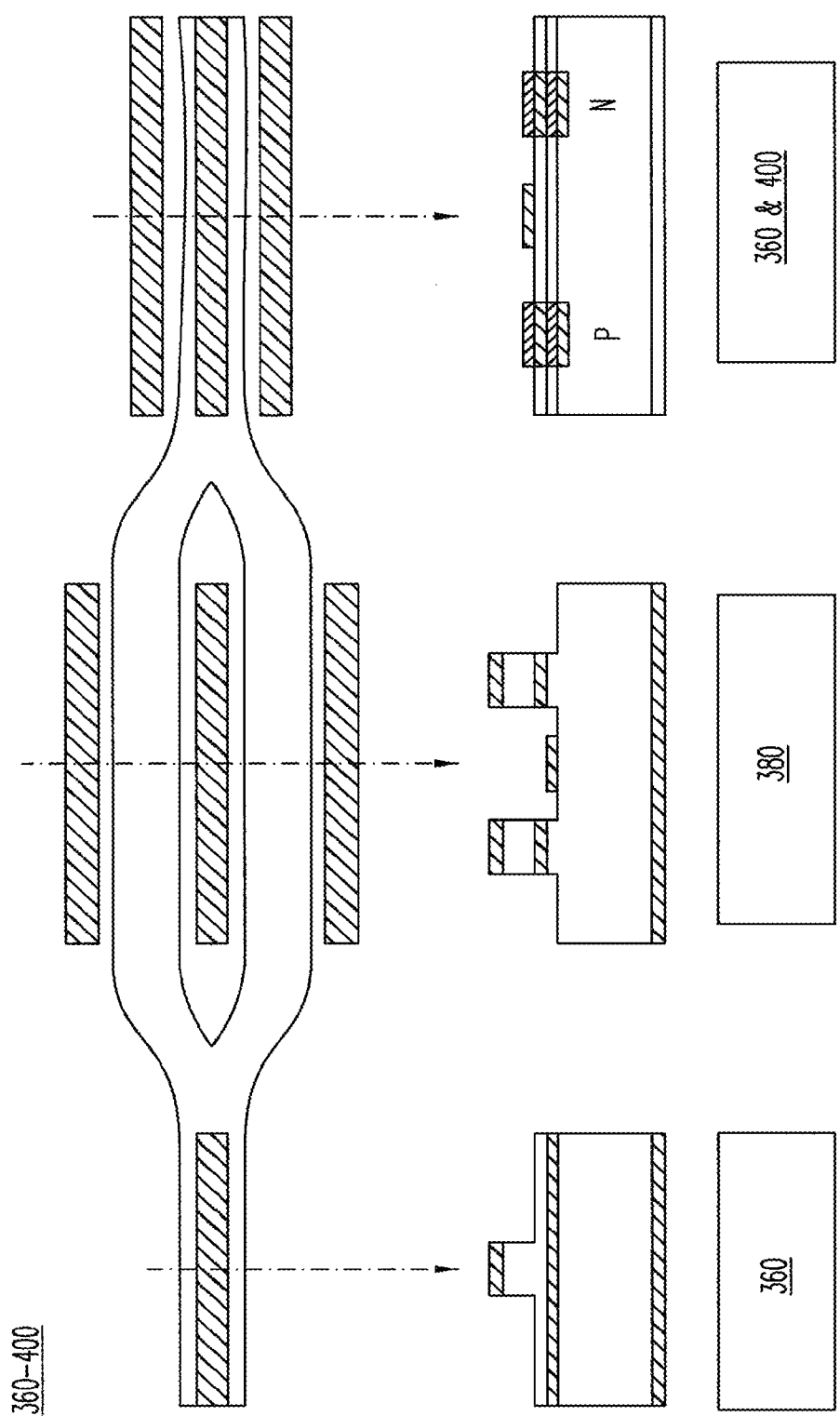


FIG. 5

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# DYNAMIC INTELLIGENT BIDIRECTIONAL OPTICAL AND WIRELESS ACCESS COMMUNICATION SYSTEM

## CROSS REFERENCE TO RELATED APPLICATIONS

The present application is related to and claims priority to (a) U.S. provisional patent application, "WAVELENGTH-SHIFTED DYNAMIC BIDIRECTIONAL SYSTEM," Ser. No. 60/868,838, filed on Dec. 6, 2006; (b) U.S. provisional patent application, "WAVELENGTH-SHIFTED DYNAMIC BIDIRECTIONAL SYSTEM," Ser. No. 60/883,727, filed on Jan. 5, 2007; and (c) U.S. provisional patent application, "INTELLIGENT INTERNET DEVICE," Ser. No. 60/970,487, filed on Sep. 6, 2007. These U.S. provisional patent applications are hereby incorporated by reference in their entireties.

## FIELD OF THE INVENTION

The present invention relates to dynamic intelligent bidirectional optical and wireless access communication system.

## SUMMARY OF THE INVENTION

According to one embodiment of the present invention, a wavelength-shifted dynamic intelligent bidirectional access optical system utilizes key optical elements such as: a quantum dot-enabled semiconductor optical amplifier, a phase modulator and an intensity modulator to provide upstream optical signals. These key optical elements reduce the Rayleigh backscattering effect on the transmission of optical signals. Reduced Rayleigh backscattering effect enables a longer-reach access network topology (more than any other current access network topology) between a subscriber unit and a super node (a super node includes many local nodes). Such a longer-reach access network topology eliminates operational costs and capital costs related to a vast array of middle equipment like routers and switches, which would otherwise be needed between super nodes and many remote nodes.

In another embodiment of the present invention, a wavelength to a subscriber unit may be protected and dynamically varied for on-Demand bandwidth, information and services.

In another embodiment of the present invention, integrated micro-processors, wireless devices, wireless sensors, RFID (radio frequency enabled identification) sensors and batteries are incorporated into an intelligent device, which may be used to sense the environment, process information, initiate action and communicate with other similar devices. Data interpretation, pattern recognition and reasoning technologies may also be utilized. Such independent interactions with other similar devices (which are integrated with micro-processors, wireless devices, wireless sensors, RFID sensors and batteries) with or without human interactions enables the Internet of Things and/or machine-to-machine communication via embedded algorithms/software.

The present invention is better understood upon consideration of the detailed description below and the accompanying drawings.

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## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows an access optical network 100, according to one embodiment of the present invention.

FIG. 2 shows an access optical network 100 where a wavelength to a subscriber unit 340 can be protected and dynamically varied for on-Demand bandwidth, information and services.

FIG. 3A shows an optical and wireless configuration of a subscriber unit 340 enabling the Internet of Things and/or machine-to-machine communication.

FIGS. 3B and 3C show two perspectives of an exemplary application of such an Internet appliance connected wirelessly or wired to a subscriber unit 340.

FIG. 3D shows an exemplary circuit block diagram of an Internet appliance connected wirelessly or wired to a subscriber unit 340.

FIG. 4 shows an exemplary processing of optical signals utilizing optical components 200-420.

FIG. 5 shows an integrated cross-sectional implementation of two quantum dot enabled semiconductor optical amplifiers 360, a phase modulator 380 and an intensity modulator 400 as described by FIG. 4.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows an access optical network 100, which is a wavelength-shifted dynamic bidirectional system, includes a super node 101, many local nodes 102 and many remote nodes 103.

An optical network 100 connects to many local nodes 102, many remote nodes 103 and a large number of subscriber units 340. At a super node 101, a number of fast switching wavelength stabilized tunable lasers 120 provide specific downstream optical signals of selected distinct wavelengths, each selected distinct wavelength being modulated by the corresponding modulators 140. The modulated wavelengths are then combined by wavelength combiner 160 and amplified by an erbium-doped fiber amplifier (EDFA) 220. The amplified wavelengths pass through a circulator 260 to be transmitted on a dispersion-compensated, single-mode optical fiber 280 to a remote node 103.

The modulated wavelengths (optical signals) are transmitted over a dispersion-compensated single-mode optical fiber 280 and then are decombined by a wavelength combiner/decombiner 300 in a remote node 103 and filtered by a tunable optical bandpass filter 240 in order to recover the selected distinct wavelengths (optical signals). The filtered wavelengths are then further decombined by an optical power combiner/decombiner 320 and are sent to multiple subscriber units 340.

Also at a local node 102 includes fast switching wavelength stabilized tunable lasers 120, which provide optical signals of selected distinct wavelengths that are each offset from the corresponding set of selected distinct wavelengths generated at a super node 101. These selected distinct offset wavelengths at local node 102 are modulated by modulators 140 and amplified by an erbium-doped fiber amplifier (EDFA) 220. The selected amplified distinct wavelengths (optical signals) transmit through an optical power combiner/decombiner 320 and are sent to multiple subscriber units 340 for upstream optical signals.

The upstream optical signals are returned through an optical power combiner/decombiner 320, a tunable optical bandpass filter 240, and a wavelength combiner/decombiner 300.

The upstream optical signals are transmitted over a dispersion-compensated single-mode optical fiber **280** to a circulator **260** of a super node **101**.

A circulator **260** provides the wavelengths to a tunable optical bandpass filter **240**, an erbium-doped fiber amplifier (EDFA) **220** and a wavelength combiner **180** for detection by a larger number of avalanche photodiodes **200** for each distinctly selected wavelength (optical signal).

FIG. 2 shows an optical network **100** where a wavelength to a subscriber unit **340** can be dynamically varied utilizing M:M cyclic arrayed waveguide grating router(s) **250**. Also a wavelength to and from a subscriber unit **340** can be protected by a 2x2 optical switch (not shown in the FIG. 2). Downstream and upstream optical signals can be separated via a ring network topology of single-mode optical fibers **280**, according to one embodiment of the present invention.

All possible switched output wavelengths of the fast switching wavelength stabilized tunable lasers **120** are arranged or displayed at the M outputs of the M:M cyclic arrayed waveguide grating router **250** because of the free spectral range periodic property of the M:M cyclic arrayed waveguide grating router **250**. The M:M cyclic arrayed waveguide grating router **250** offers the flexibility of routing more than one wavelength to any subscriber unit **340** for on-demand bandwidth, information and services.

FIG. 3A shows an exemplary configuration of a subscriber unit **340**, according to one embodiment of the present invention. As shown in FIGS. 3A, 4 and 5, a subscriber unit includes a tunable optical bandpass filter **240**, an avalanche photodiode **200**, a circulator **260**, optical processing components **360-420**, an electrical to optical amplifier circuit **440**, an avalanche photodiode circuit **460** and a media access and algorithm flow/quality of service (QoS) management controller **480**.

More than ever before, we are more mobile and more global. Our ability to access any content, any time and from any place is critical. A converged pervasive always-on Internet will be the global network of human connections, ideas, collaboration, commerce and distributed intelligence. Therefore, an intelligent device that allows access of any content over the Internet is desirable with or without human intervention.

According to another embodiment of the subscriber unit **340**, an intelligent device (which is based on emerging convergence of numerous platforms, for example: computing, communication, device to device communication, sensory input processing, entertainment, medicine, artificial intelligence and Internet of Things and/or machine-to-machine communication, enabling self learning with or without human intervention) may include a micro-processor device, an operating system/software and various embedded software for operation, control and management, one or more Internet access devices, a display device, a keyboard device, a storage device, a battery, a power management device, a voice/video/data over Internet protocol device, a multimedia device, a GPS device and a near-field communication device. Benefits of Such a Device

#### Simple<sup>1</sup> to use

<sup>1</sup> "If one can package it in a way that's easy—brainlessly easy—for the end user, that's when things are really going to take off".

#### Intelligent

Convergent (of computing, communication and cable TV network platforms)

Open hardware and software architectures

Seamless communication over Internet protocol

Capable of time shifting any content

Capable of place shifting any content

Capable of location recognition for navigation

Capable of searching physical things via RFID reading device and GPS

Capable of the Internet of Things and/or machine-to-machine communication

Capable of remote control of life and health

Capable of nano-medicine based diagnostics

Potentially a disruptive business model based on emerging convergence of numerous platforms, for example: computing, communication, entertainment, medicine, artificial intelligence/fuzzy logic and Internet of Things and/or machine-to-machine communication. Thus it enables an intelligent system for self learning with or without human intervention.

As shown in FIG. 3A, a media access and algorithm flow/quality of service (QoS) management controller **480** multiplexes/demultiplexes the electrical or optical signals to a number of connectivity devices for various applications, incorporating an IP address (**500**); a micro-processor device (**520**); an operating software/system (**540**); an Internet access device (**560**); an Internet firewall including spyware, parental and security (e.g., finger-print recognition and retinal scan) control capabilities (**580**); a display device, or a stretchable nano-technology based display device or an organic light emitting display (**600**); a keyboard, a stretchable keyboard device, a touch screen keyboard, a infrared illuminated keyboard or a voice activated keyboard (**620**); a battery, a nano-technology based solar cell, or a wireless charger (**640**); a storage device, a holographic storage device, or an Internet enabled storage device (**660**); a microphone device (**680**); a camera (**700**); a video compression device (**720**); a GPS device (**740**); a projection display device (**760**); an MMIC (millimeter wave IC) or UWB (ultra wideband) or NG (Next Generation) wireless connection device or Wi-Max connection device or WIFI connection device (**780**); a Bluetooth device (**800**); a RFID reading device (**820**); a near-field communication device (**840**) for any point-of-purchase; a remote connection and content transfer device (**860**) from phone to computer to TV; an in-situ diagnostic and a remote control device (**880**); a web-based content management device (**900**) for place shifting; an artificial intelligence or pattern recognition-based device (**920**) for interpreting user profiles and preferences; an artificial intelligence or fuzzy logic-based device for automatic searches, recommendations, suggestions and fetching of content (**940**); a voice-over-Internet protocol device (**960**); a video-over-Internet protocol device (**980**); a data-over-Internet protocol device (**1000**); and a device integrated with micro-processors, wireless devices, wireless sensors, RFIDs and batteries and embedded algorithm (**1020**) enabling the Internet of Things and/or machine-to-machine communication.

Such an intelligent device may be connected to a digital gateway/broadband router (**1040**), a set-top box (**1060**) and a personal video recorder (**1080**) via a sensor, a wired connection, or a wireless connection. The combinations of various capabilities of many devices incorporated into an intelligent device create many novel consumer applications. For example, having an Internet access device (**560**), a GPS device (**740**) and an RFID reading device (**820**) incorporated into such an intelligent device allows a new application of physical search. As many products have RFID tags, an RFID reading device (**820**) of an intelligent device may be used to retrieve the RFID information and other embedded content from a product when a consumer encounters the product. The

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consumer may then further search all non-confidential product information, including, availability, pricing and distribution via the Internet. Using a GPS device (740) in the intelligent device may even locate distribution locations where the same product can be purchased, ranked according to price. Other applications are possible because of the seamless capabilities provided on the intelligent device.

By utilizing an ultra-high resolution and very high contrast ratio touch sensitive monochrome or color display and a stylus; an electronic sketchpad may be created.

An intelligent device of the present invention may have many radios and antennas. The wireless capabilities can be further simplified by a software-defined radio, where a radio, controlled by software, utilizes a broadband antenna and a carbon-nanotube tunable radio-frequency cavity filter to access or tune to a wide range of frequencies, instead of a single band.

An intelligent device of the present invention may be designed for short-range communication. The intelligent device may enable the device to act like a node in a wireless-sensor network, having more power and processing capabilities than the other sensors, and collect information about the environment (e.g., pictures or location information). The intelligent device may also aggregate data from nearby sensors, process such information, and send such information to other sensors, devices, and intelligent devices via wired, wireless or sensor networks.

Moreover, home sensors (e.g., built-in security sensors, utility sensors and moisture sensors), infrared sensors and health sensors may be also connected or incorporated.

As shown in FIG. 3B and FIG. 3C, an intelligent device of the present invention allows a user to make telephone calls, send instant video messages, send instant messages, send instant pictures, watch TV programs, play games and send medical diagnostics over the Internet and utilize it as a mobile nano-computer at any time and from any place. This also can securely store financial information such as credit card information and reduce any further need for keeping separate financial information. Near-field communication device(s) along with an RFID reading device incorporated into an intelligent device may allow, for example, payment at any point-of-purchase. This is an open and flexible architecture in hardware and software. A design example with a circuit block diagram is shown in FIG. 3D, where a microprocessor device (520) controlled by an operating software/system software (540) is connected to various components as: 10 (power reset), 12 (camera controller), 14 (McBSP connection), 16 (GPIO connection), 18 (MS/MMC/SD/SDIO connection), 20 (Memory controller), 22 (Storage controller), 24 (USB connection), 26 (USB OTG connection), 28 (UART connection), 30 (SDIO connection), 32 (12C connection), 34 (IrDA connection), 36 (Display controller), 38 (SPI connection), 40 (Touch screen display controller), 42 (Power management chip), 44 (Audio code), 46 (Micro SD slot), 48 (Mobile DDR), 50 (NAND/NOR Flash), 52 (HHD), 54 (USB hub), 56 (Mini USB hub), 58 (FIR port), 60 (Speaker), 62 (MIC), 64 (Headset), 600 (Display), 600.1 (External display), 620 (Keyboard), 640 (Battery), 700 (Camera), 740 (GPS module), 780.1 (WLAN module), 780.2, (WiMax module), 780.3 (Next Generation wireless module) and 800 (Bluetooth module).

Integrated micro-processors, wireless devices, wireless sensors, RFID sensors, and batteries incorporated into an intelligent device may be used to sense the environment, to process information, to initiate action and to communicate with other similar devices. Data interpretation, pattern recognition and reasoning technologies may be utilized to allow

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these devices to communicate with and/or without human intervention and to operate independently and intelligently. Such independent interactions with other similar devices (which are integrated with micro-processors, wireless devices, wireless sensors, RFID sensors and batteries incorporated can enable the Internet of Things and/or machine-to-machine communication via embedded algorithms.

For example, holographic images of DNA stored in an intelligent device could be projected in a physical space or on the Internet to enable a physician to design personalized medical or surgical treatment. Such an intelligent device can be self-learning and enable the remote-control for life and health (via, for example, nanotechnology-based in-situ implanted medical sensors and web based medicine).

FIG. 4 shows an exemplary processing of optical signal processing in components 200-420. As shown in FIG. 4, downstream optical signals are divided by a tunable optical bandpass filter 240 to an avalanche photodiode 200 for receiving optical signals. Upstream optical signals with the slightly offset distinctly selected wavelengths are provided to a tunable optical bandpass filter 240, which forwards the filtered optical signals to a circulator 260. The upstream optical signals are looped back through a quantum dot enabled semiconductor optical amplifier 360 and a phase modulator 380. The phase-modulated optical signals are further amplified by a quantum dot enabled semiconductor optical amplifier 360 and modulated in intensity by an intensity modulator 400. Both phase and intensity modulated optical signals are then transmitted through a variable optical intensity attenuator 420 for upstream optical signals to a super node 101 through a circulator 260.

Using a quantum dot enabled semiconductor optical amplifier 360, a phase modulator 380 and an intensity modulator 400 in the manner shown in FIG. 4 to reduce the Rayleigh backscattering effect on the transmission of optical signals, thus enabling a simplified network topology to support a longer reach between a super node 101 and a remote node 103 and, thereby eliminating a vast array of middle equipment such as routers and switches, which would otherwise be needed between super nodes 101 and many remote nodes 103. Also, a pilot tone modulation may be provided to a quantum dot enabled semiconductor optical amplifier 360 at a subscriber unit 340 and a fast switching wavelength stabilized tunable laser 120 at a super node 101 to reduce any backscattering effect. Furthermore, all optical fiber connectors may be angle polished to reduce further optical back-reflection.

According to one embodiment of the present invention, an upstream wavelength may be shared among multiple subscriber units 340 (e.g., using a time division multiplexed statistical bandwidth allocation technique), hence burst mode electronics with a forward error correction may be provided at a super node 101 to process the upstream optical signals from multiple subscriber units 340, but the downstream optical signals from a super node 101 to subscriber units 340 may be transmitted under broadcast mode conditions.

In another embodiment of the present invention, burst mode electronics with a forward error correction may be provided both at a super node 101 and subscriber units 340 to process both upstream and downstream optical signals, using a time division multiplexed statistical bandwidth allocation technique.

FIG. 5 shows an exemplary integrated cross-sectional implementation of two quantum dot enabled semiconductor optical amplifiers 360, a phase modulator 380 and an intensity modulator 400, according to one embodiment in a cross-section of the present invention.

The above detailed description is provided to illustrate specific embodiments of the present invention and is not intended to be limiting. Numerous modifications and variations within the scope of the present invention are possible.

I claim:

1. An optical system for communicating optical signals to and from a subscriber unit, comprises:

a first set of selected wavelengths;

a second set of selected wavelengths offset from the first set of selected wavelengths;

a first subsystem configured to transmit to the subscriber unit, the optical signals of one or more wavelengths from the first set of selected wavelengths over an optical fiber;

a second subsystem configured to transmit to the subscriber unit the optical signals of one wavelength selected from the second set of selected wavelengths in statistical time division multiplexing over the optical fiber;

a third subsystem at the subscriber unit configured to receive the optical signals of the one or more wavelengths from the first set of selected wavelengths and the optical signals of one wavelength from the second set of selected wavelengths over the optical fiber;

a fourth subsystem at a head-end configured to receive looped back optical signals of one wavelength from the second set of selected wavelengths from the subscriber unit to the head-end over the optical fiber;

a cyclic arrayed waveguide grating router capable of routing more than one wavelength to the subscriber unit; and a phase modulator, an intensity modulator, an amplifier and a looped back configuration within the subscriber unit.

2. An optical system as in claim 1, further comprising a 3-port circulator.

3. An optical system as in claim 1, further comprising a wavelength combiner/decombiner for wavelength combining or wavelength decombining of two or more wavelengths.

4. An optical system as in claim 1, further comprising a power combiner/decombiner for power combining or power decombining one or more wavelengths.

5. An optical system as in claim 1, further comprising a plurality of lasers and detectors.

6. An optical system as in claim 5, further comprising a plurality of wavelength-stabilized lasers.

7. An optical system as in claim 5, further comprising a plurality of tunable lasers.

8. An optical system as in claim 5, further comprising a plurality of plurality of fast-switching lasers.

9. An optical system as in claim 5, further comprising one or more components selected from the group consisting of: a photodiode, a photodiode plus linear semiconductor optical amplifier, an avalanche photodiode, a fast-switching photodiode and a tunable photodiode.

10. An optical system as in claim 5, further comprising one or more circuits selected from the group consisting of: a burst-mode circuit and a forward-error correction circuit.

11. An optical system as in claim 1, further comprising a plurality of intensity modulators for modulating light intensities from the laser sources.

12. An optical system as in claim 1, further comprising an amplifier for amplifying the modulated optical signals.

13. An optical system as in claim 12, further comprising an erbium doped fiber amplifier.

14. An optical system as in claim 12, further comprising a semiconductor optical amplifier.

15. An optical system as in claim 1, further comprising a cyclic arrayed waveguide grating router.

16. An optical system as in claim 1, wherein the subscriber unit further comprises an intensity modulator for intensity modulation of the optical signals selected from the one wavelength from the second set of wavelengths.

17. An optical system as in claim 1, wherein the subscriber unit further comprises a phase modulator for phase modulation of the optical signals selected from the one wavelength selected from the second set of wavelengths.

18. An optical system as in claim 1, wherein the subscriber unit further comprises a quantum dot-enabled semiconductor optical amplifier for amplifying intensity modulated optical signals selected from one wavelength from the second set of wavelengths.

19. An optical system as in claim 1, wherein the subscriber unit further comprises a quantum dot-enabled semiconductor optical amplifier for amplifying phase modulated optical signals selected from one wavelength from the second set of wavelengths.

20. An optical system as in claim 1, wherein the subscriber unit further comprises a circulator for looping back the optical signals of one wavelength of the second set of wavelengths, after optically processing said looped back optical signals, in the subscriber unit.

21. An optical system as in claim 1, wherein the subscriber unit further comprises a media access controller and a data flow management controller.

22. An optical system as in claim 21, wherein the subscriber unit further comprises a quality of service.

23. An optical system as in claim 21, wherein the subscriber unit further comprises a phase modulator, an intensity modulator and a quantum dot-enabled semiconductor amplifier that are fabricated on a same semiconductor substrate.

24. An optical system as in claim 21, wherein the subscriber unit is further configured to receive one or more wavelengths on demand.

25. An optical system in claim 21, wherein the subscriber unit is further configured to receive bandwidth on demand.

26. An optical system as in claim 21, wherein the subscriber unit is further configured to receive wavelength protection on demand.

27. An optical system as in claim 21, wherein the subscriber unit is further configured to transmit or receive the optical signals via a coordinated statistical time division multiplexing.

28. An optical system as in claim 21, wherein the subscriber unit further comprises an optical signal processing circuit, comprising:

a phase modulator for modulating the optical signal;

an intensity modulator for modulating the optical signal;

a semiconductor optical amplifier for amplifying the optical signal; and

a circulator for looping back optical signal over an input terminal.

29. An optical system in claim 28, further comprising an increased link distance between the subscriber unit and head-end resulting from a reduction of scattering.

30. An optical system as in claim 21, wherein the subscriber unit further comprises an embedded algorithm.

31. An optical system as in claim 21, wherein the subscriber unit further comprises an internet communicator.

32. An optical system as in claim 21, wherein the subscriber unit further comprises one or more security modules selected from the group consisting of: internet security, firewall and parental control.

33. An optical system as in claim 21, wherein the subscriber unit further comprises one or more internet protocol

(IP) modules selected from the group consisting of: voice-over-IP, video-over-IP and data-over-IP.

**34.** An optical system as in claim **21**, wherein the subscriber unit further comprises one or more electronic modules selected from the group consisting of: a set-top box, a video recorder, a place shifter and a time shifter. 5

**35.** An optical system as in claim **21**, wherein the subscriber unit further comprises one or more communication modules selected from the group consisting of: a wire, a wireless and a sensor.

**36.** An optical system as in claim **21**, wherein the subscriber unit further comprises one or more identification modules selected from the group consisting of: radio frequency identification and an identification sensor.

**37.** An optical system as in claim **21**, wherein the subscriber unit further comprises one or more sensor modules selected from the group consisting of: home control and health care.

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