

Nokia of America Corp. and AT&T Services Inc.,
Petitioners,
v.
Iarnach Technologies Ltd.,
Patent Owner.

U.S. Patent No. 9,806,892

IPR2024-00899

Petitioners' Demonstratives | Under 37 C.F.R. § 42.70(b)
September 18, 2025, Oral Argument

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE – 1

Nokia of America Corporation et al.
Exhibit 1044
IPR2024-00899, USPN 9,806,892
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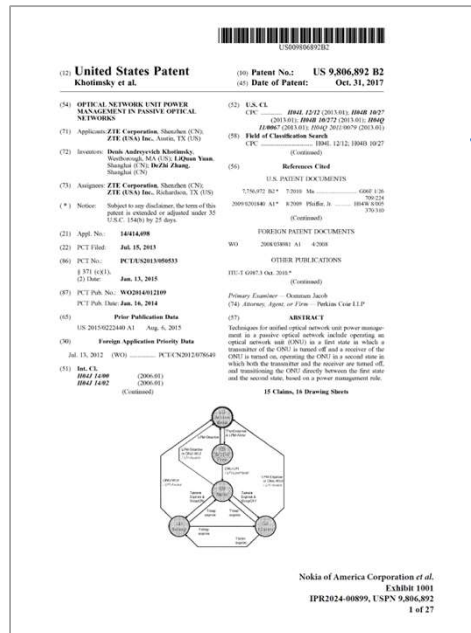
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OVERVIEW OF THE '892 PATENT



'892 Patent

(12) United States Patent Khotimsky et al.

(10) Patent No.: **US 9,806,892 B2**
(45) Date of Patent: **Oct. 31, 2017**

(54) OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS

(71) Applicants: **ZTE Corporation, Shenzhen (CN);
ZTE (USA) Inc., Austin, TX (US)**

(72) Inventors: **Denis Andreyevich Khotimsky,
Westborough, MA (US); LiQuan Yuan,
Shanghai (CN); DeZhi Zhang,
Shanghai (CN)**

(52) U.S. CL.
CPC **H04L 12/12 (2013.01); H04B 10/27
(2013.01); H04B 10/272 (2013.01); H04Q
11/0067 (2013.01); H04Q 2011/0079 (2013.01)**

(58) Field of Classification Search
CPC **H04L 12/12; H04B 10/27**

(Continued)

(56) References Cited

(22) PCT Filed: **Jul. 15, 2013**

(86) PCT No.: **PCT/US2013/050533**

§ 371 (c)(1),
(2) Date: **Jan. 13, 2015**

(87) PCT Pub. No.: **WO2014/012109**

PCT Pub. Date: **Jan. 16, 2014**

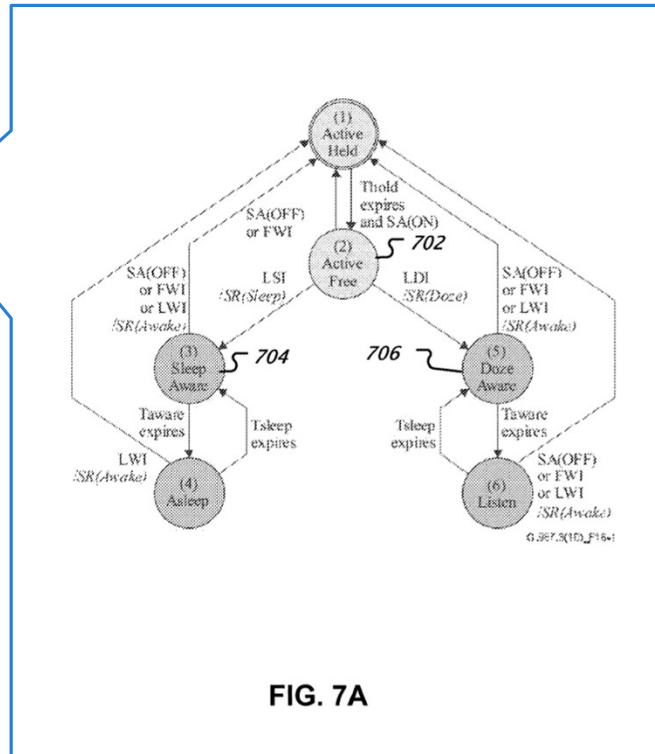
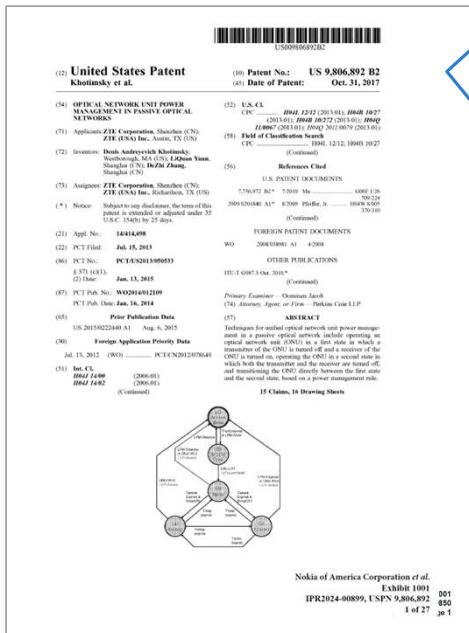
(65) **Prior Publication Data**

US 2015/0222440 A1 Aug. 6, 2015

(30) **Foreign Application Priority Data**

Jul. 13, 2012 (WO) PCT/CN2012/078649

OVERVIEW OF THE '892 PATENT



D. The '892 Patent's Specification

54. The '892 Patent discloses a "passive optical network" including an "optical line terminal" in connection with one or more "optical network unit[s]" (ONUs). Ex. 1001 ('892 Patent), 1:19-41. The specification of the '892 Patent also cites to G.987.3 as disclosing a passive optical network. Ex. 1001 ('892 Patent), 4:25-29. The ONUs of the '892 Patent can operate in an "ONU Dozing mode," in which the ONU transmitter is powered off and the ONU receiver is powered on. Ex. 1001 ('892 Patent), 4:17-24. A parameter may be configured to the ONU specifying

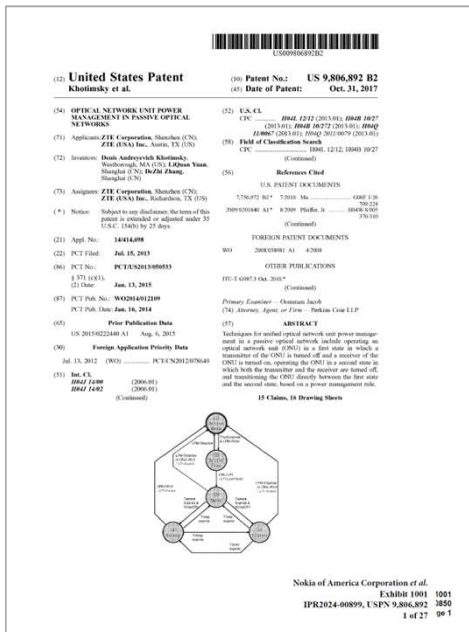
Ex. 1003 at ¶154

'892 Patent

– Ex. 1001 at FIGs. 7A; Ex. 1007 at Fig. 16-1, Paper 18 at 2; Ex. 1003 at ¶154.

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE – 5

OVERVIEW OF THE '892 PATENT



'892 Patent

1. A method of optical communication in a passive optical network, comprising:

operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on;

operating the ONU in a second state in which both the transmitter and the receiver are turned off;

transitioning the ONU directly from the first state to the second state and transitioning the ONU directly from the second state to the first state, based on a power management rule;

ensuring the ONU is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control before exiting the first state or the second state; and

receiving, by the receiver, a power management message from an optical line terminal (OLT); and

changing the power management rule based on the received power management message.

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Overview of the Disputes



PO admits that direct transitions are disclosed by the prior art.



PO admits that direct transitions were known by POSITAs.



PO admits that direct transitions were one of a limited number of possible choices.



PO concedes invalidity of Claim 14 under the correct claim construction.

Overview of the Disputes



PO argues that POSITA would not be motivated to implement direct transitions.



PO argues that POSITA would not be able to implement direct transitions to G.987.3.



PO argues inconsistent positions for remaining claims.



PO argues that a limitation should be imported from the specification into Claim 14.

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Claim Construction

“Patent Owner clarifies and more narrowly tailors its previous position put forth in the Preliminary Response. Specifically, Patent Owner modifies the term that the Board should construe from “transition” to “transition . . . from . . . to,” and re-urges that **Claim 14 requires a direct transition** from the first low power mode to the second low power mode and *vice versa* for the following reasons.”

Paper 21 at 6-7 (emphasis added)

wherein the ONU is configured to transition from the **first low power mode** to the **second low power mode** and to transition from the **second low power mode** to the **first low power mode** based on a power management rule,

Claim 14

Claim Construction

transitioning the ONU **directly** from the **first state** to the **second state** and transitioning the ONU directly from the **second state** to the **first state**, based on a power management rule;

Claim 1

means for **transitioning** the ONU **directly** from the **first state** to the **second state** and means for **transitioning** the ONU **directly** from the **second state** to the **first state**,

Claim 6

wherein the processor includes means for **transitioning** the ONU **directly** from the **first state** to the **second state** and means for **transitioning** the ONU **directly** from the second state to the first state,

Claim 10

Direct Transition

Direct Transition

Direct Transition

Claim Construction

Direct or Indirect Transition

Direct or Indirect Transition

a processor configured to generate messages for controlling a transition of an optical network unit **from a first low power state** in which a receiver of the optical network unit is turned on but a transmitter of the optical network unit is turned off **to a second low power state** in which both the receiver and the transmitter of the optical network unit are turned off;

Claim 12

wherein the ONU is configured to transition from the **first low power mode** to the **second low power mode** and to transition from the **second low power mode** to the **first low power mode** based on a power management rule,

Claim 14

Direct

transitioning the ONU **directly** from the **first state** to the **second state** and transitioning the ONU directly from the **second state** to the **first state**, based on a power management rule;

Claim 1

means for **transitioning** the ONU **directly** from the **first state** to the **second state** and means for **transitioning** the ONU **directly** from the **second state** to the **first state**,

Claim 6

wherein the processor includes means for **transitioning** the ONU **directly** from the **first state** to the **second state** and means for **transitioning** the ONU **directly** from the second state to the first state,

Claim 10

Direct or Indirect

a processor configured to generate messages for controlling **a transition** of an optical network unit **from a first low power state** in which a receiver of the optical network unit is turned on but a transmitter of the optical network unit is turned off **to a second low power state** in which both the receiver and the transmitter of the optical network unit are turned off;

Claim 12

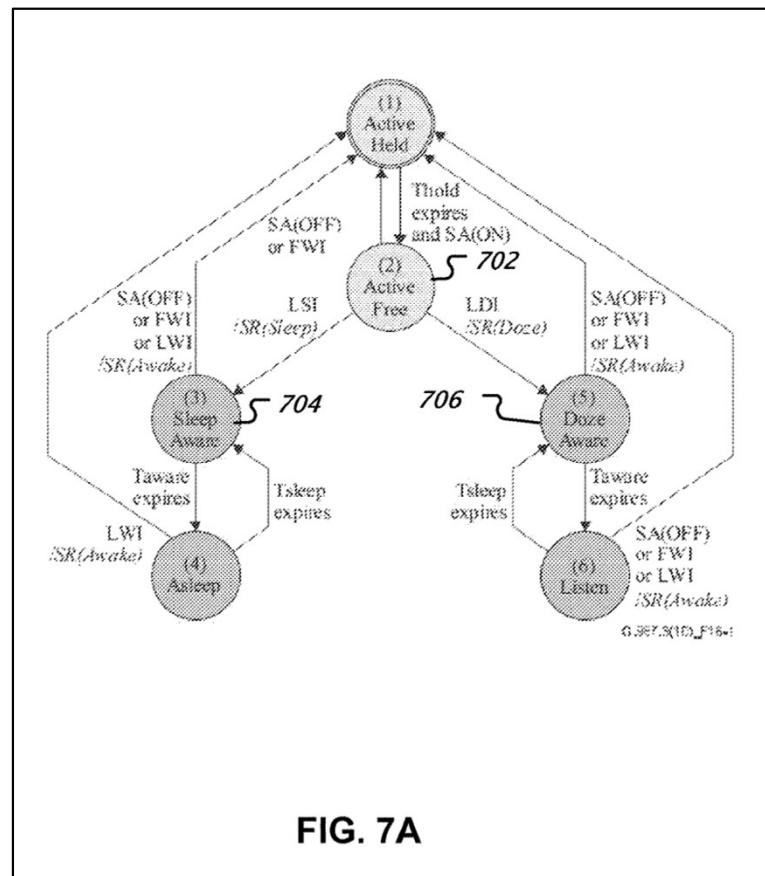
wherein the ONU is configured to **transition** from the **first low power mode** to the **second low power mode** and to **transition** from the **second low power mode** to the **first low power mode** based on a power management rule,

Claim 14

Claim Construction

FIG. 7A shows the state machine behavior 700 of a PON ONU, as specified in one currently published PON standard (ITU-T G.987.3, 10-Gigabit-capable passive optical networks (XG-PON): Transmission convergence (TC) layer specification, publication date October 2010). From the initial state “Active Free” 702, the ONU can either transition into a Sleep Aware state 704 or a Doze Aware state 706 (further described below). However, no direct transition between the Doze Aware and the Sleep Aware states 704, 706 are provided. Conventional ONUs therefore lack the technology of directly transitioning between two low power consumption states without having to go through an active state (e.g., a full powered state). In one detrimental aspect, such a transition through the active state may increase the power consumed by the ONU, thereby undesirably reducing batter life.

Ex. 1001 at 4:25-40



Ex. 1001 at Fig. 7A

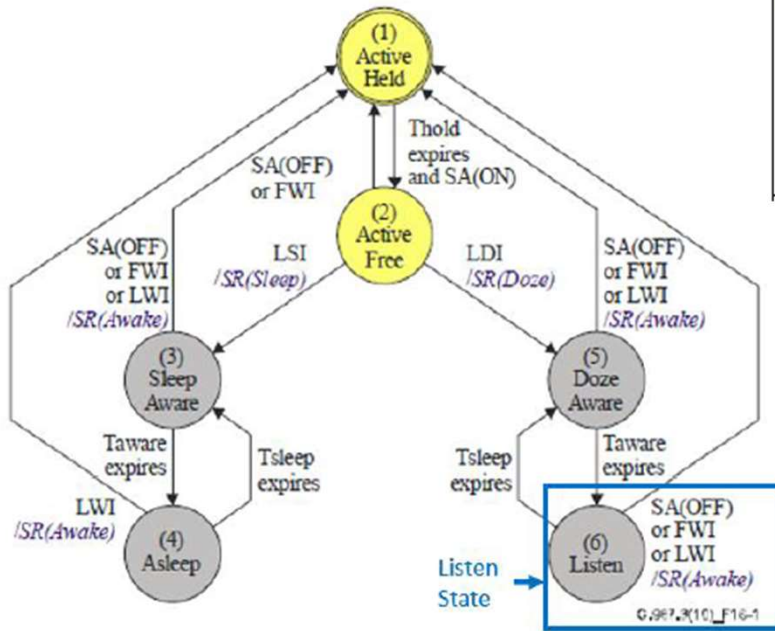
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First State

First State: RX: ON | TX: OFF

Ex. 1007, Fig. 16-1 (annotated)



Listen

The ONU receiver is on; the transmitter is off. The ONU listens to the downstream signal and forwards downstream traffic, while retaining the ability to reactivate the transmitter on local stimulus or receipt of SA(OFF) from the OLT. This state persists for a specified duration *Isleep* if not truncated by the arrival of a local stimulus LWI or receipt of SA(OFF) or FWI from the OLT. Before exiting this state, the ONU ensures that it is fully powered up and capable of responding to both upstream and downstream traffic and control.

Ex. 1007, G.987.3

First State

First State: RX: ON |TX: OFF

Ex. 1006, Table 2

Table 2. Subscriber operating modes and total DC supply currents I_b for a supply voltage $V_b = 3.6\text{ V}$.

Subscriber modes		Attributes	μC current $I_{\mu\text{C}}$	Supply current I_b	Total I_b
Sleep	μC low-power modes	Low-Q clock	$0.5\text{ }\mu\text{A}$	I_{Sleep}	$0.5\text{ }\mu\text{A}$
Snooze		High-Q clock	$1\text{ }\mu\text{A}$	I_{Snooze}	$1\text{ }\mu\text{A}$
Receive	μC active mode	Receiver on	3.5 mA	I_{Rx}	6 mA
Transceive		Transceiver on		I_{RxTx}	11 mA

Like G.987.3, Röger teaches 1[B]. Ex. 1003, ¶78. Röger teaches that subscribers (ONUs) in a sleep mode (i.e., with receiver and transmitter off) “*activate their basic receiver circuitry*” during wake-up intervals to “listen for the [OLT’s] polling.” Ex. 1006, 8; Ex. 1003, ¶78. Thus, the ONU of Röger transitions to a “receive” mode (“first state”) with its receiver on and its transmitter off. Ex. 1003, ¶78. Additionally, the blue boxes in annotated table 2 (reproduced below) shows the receive mode with a receiver (but no transmitter) powered on. Ex. 1006, 11; Ex. 1003, ¶78. Thus, Röger likewise teaches 1[B]. Ex. 1003, ¶78; *see also* Ex. 1005, 8-9.

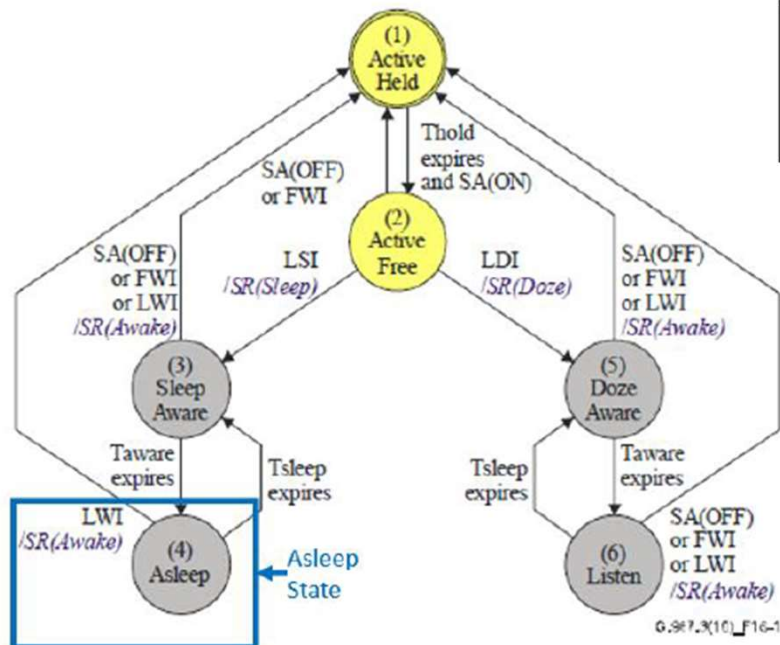
Ex. 1006, Röger

Petition

Second State

Second State: RX: OFF |TX: OFF

Ex. 1007, Fig. 16-1 (annotated)



Asleep

The ONU shuts down both its receiver and transmitter, retaining the ability to wake up on local stimulus. This state persists for a specified duration *Isleep* if not truncated by the arrival of a local stimulus *LWI*. Before exiting this state, the ONU ensures that it is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control.

Ex. 1007, G.987.3

Second State

Second State: RX: OFF |TX: OFF

Ex. 1006, Table 2

Table 2. Subscriber operating modes and total DC supply currents I_b for a supply voltage $V_b = 3.6$ V.

Subscriber modes		Attributes	μ C current $I_{\mu C}$	Supply current I_b	Total I_b
Sleep	μ C low-power modes	Low-Q clock	0.5 μ A	I_{Sleep}	0.5 μ A
Snooze		High-Q clock	1 μ A	I_{Snooze}	1 μ A
Receive	μ C active mode	Receiver on	3.5 mA	I_{Rx}	6 mA
Transceive		Transceiver on		I_{RxTx}	11 mA

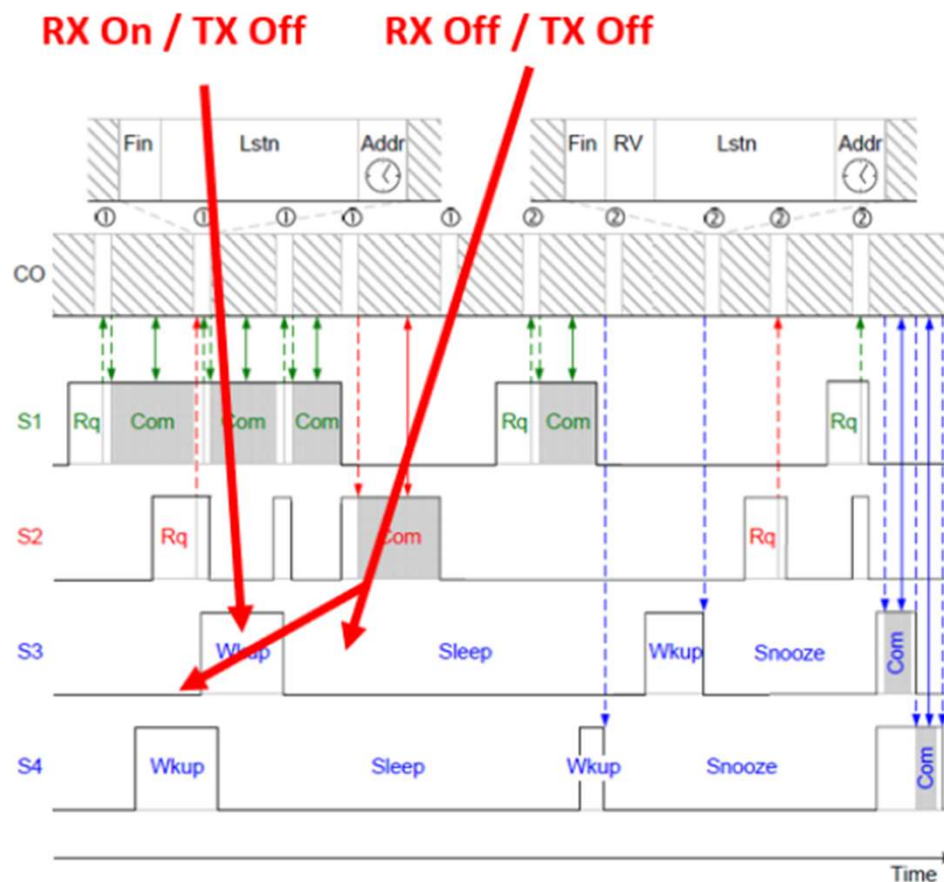
Likewise, Röger teaches 1[C]. Ex. 1003, ¶80. Röger teaches a sleep mode (“second state”) for ONTs which requires “[a]ll communication circuitry switched off.” Ex. 1006, 6; Ex. 1003, ¶80. Röger further teaches a “snooze mode” in which “all dispensable circuitry” (including the receiver and transmitter) is shut down. Ex. 1006, 9; Ex. 1003, ¶80. The sleep and snooze modes are boxed in blue in annotated table 2 (reproduced below). Ex. 1006, 11; Ex. 1003, ¶80. Thus, Röger likewise teaches 1[C]. Ex. 1003, ¶80; *see also* Ex. 1005, 10-11.

Ex. 1006, Röger

Petition

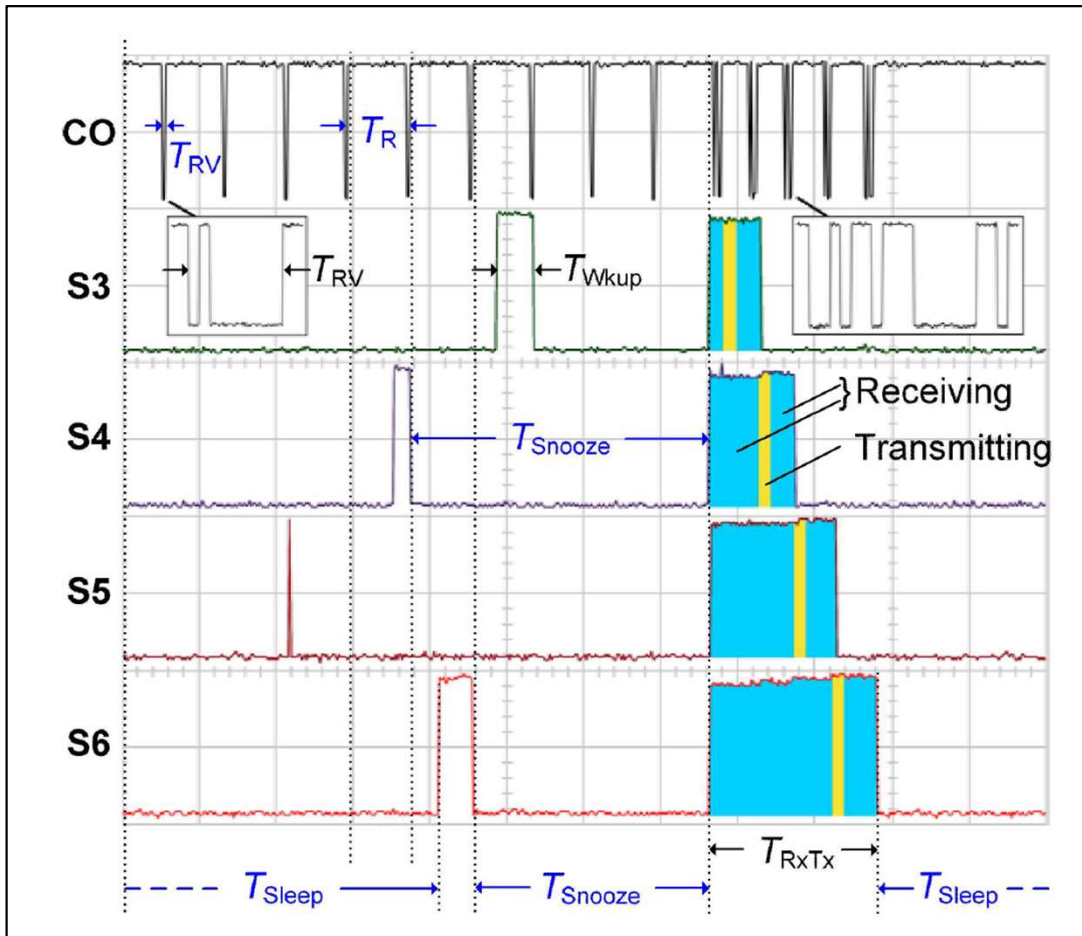
Direct Transitions

Ex. 1006, Fig. 2 (annotated)



Ex. 1006, Röger

Direct Transitions



“At rendezvous time all subscribers switch to receive mode and stay listening for their address to be broadcast by CO (signal details see right inset of Fig. 6). When for instance subscriber S4 recognizes its address (transition from the dark (blue) to the light (yellow) region in Fig. 6), it activates its transmitter, sends to CO whatever information was required, and deactivates its transmitter again (transition from the light (yellow) to the dark (blue) region in Fig. 6).”

Ex. 1006, Röger

Direct Transitions

¶110. With so few realistic power saving options the ITU standard body undoubtedly considered all of them, including the direct transition from Doze-Listen and Cyclic Sleep -Asleep. That this is not allowed means the ITU had rejected the

**Ex. 2007,
Dr. Litvin
Declaration**

it. Ex. 2007 ¶¶108–10. Indeed, this is not speculation: G.987.3 *explicitly considered* the very direct transitions that Petitioners say would be used, but G.987.3 *still taught that direct ONU transitions from the Sleep to Doze states were not allowed*. Ex. 1007 Tbl. 16–7 n.2, at 105.

**Patent Owner
Response**

MOTIVATION TO COMBINE

16 ONU power management

For a variety of reasons, it is desirable to reduce the power consumed by an ONU as much as possible:

- Over time, the natural evolution of technology tends toward more efficient realizations of given functions, a tendency that is offset, at least to some extent, by increasing levels of functionality and speed.
- If there is a way for the ONU to determine that a subscriber interface is idle, it is desirable for the ONU to power down the circuitry associated with that interface, while retaining the capability to detect subscriber activity on that interface. The details vary as a function of the interface type.
- The extent of feasible power reduction depends on the acceptable effect on service. The maximum possible savings occurs when a subscriber intentionally switches off an ONU, for example, overnight or during a vacation.
- During failures of AC power, some degradation of service is generally acceptable. To conserve backup battery lifetime, it is desirable for the ONU to power down circuitry associated with all interfaces, except those considered to provide essential services. Different operators and customers may have different definitions of essential services, and may wish to prioritize the time when the interfaces are powered down. This feature, which is known as power shedding, is described in [ITU-T G.988].

The preceding techniques for power management are a matter of ONU design and subscriber and operator practice, and are beyond the scope of this Recommendation.

This clause addresses two additional means of power management, which do require TC layer support.

One is called doze mode; the other is referred to as cyclic sleep mode. Both are statically provisioned through OMCI, and either or both of these latter modes may be combined with any or all of the other power reduction techniques.

All ITU-T G.987.3-compliant implementations are expected to support the doze mode. Support of the cyclic sleep mode is optional for both OLT and ONU.

Ex. 1007, G.987.3

MOTIVATION TO COMBINE

In this paper we discuss an optically powered fiber network that connects and provides power to a multitude of subscribers, which are attached to a central office (CO) in a combined star and tree-like topology. The focus of this paper is on energy optimized subscriber hardware in combination with a new and flexible *low-energy medium-access control* (LE-MAC) protocol, which enables efficient use of the optically provided energy that is transmitted to each subscriber. Both, energy-hungry subscribers with high network priority (as is the need for video conferencing) and energy-preserving subscribers having a low network priority and a very small duty cycle (e. g., temperature or humidity sensors), can be handled by the CO simultaneously.

3. Low-energy medium access control (LE-MAC) protocol

In this section we present a *low-energy medium access control* (LE-MAC) protocol that serves the needs for optically powered heterogeneous subscribers in a simple and effective manner. To operate all subscribers with the least possible power consumption we extend specifications of common *medium access control* (MAC) protocols with the following features:

Ex. 1006, Röger

MOTIVATION TO COMBINE

“It would have been obvious to the POSITA to allow for direct transitions between a first state (e.g., Listen mode) and a second state (e.g., Asleep mode). Ex. 1003, ¶70. This modification to direct transitions would have been driven by a well-known problem in the field, reducing power consumption. Ex. 1003, ¶70. G.987.3 states, “it is desirable to reduce the power consumed by an ONU as much as possible.” Ex. 1007, 97; Ex. 1003, ¶70. As was well known, it was desirable to reduce power to realize “more efficient realizations of given functions.” Ex. 1007, 97; Ex. 1003, ¶70. Greater power consumption increases cost, and in a PON with multiple ONUs, saving power at each ONU can lead to a significant reduction in total cost. Moreover, there are a finite number of solutions to reduce power consumption in optical networks. Possible transitions between different low power states are even more limited given the limited numbers of power states and scenarios for an ONU to transition between them. Ex. 1003, ¶70. Therefore, it would have been obvious to a POSITA and obvious to try the finite number of transitions and find that direct transition between Listen mode and Asleep sleep mode reduces power consumption compared to transitioning to a full power state in between Listen mode and Asleep sleep mode. Ex. 1003, ¶70.”

Petition

MOTIVATION TO COMBINE

“A POSITA would have had a reasonable expectation of success when applying the direct transitions of Röger to the PON of G.987.3, since both systems include ONUs communicating with an OLT. Ex. 1006, 5; Ex. 1007, 10; Ex. 1003, ¶74. G.987.3 states that when an ONU receives a Sleep_Allow(ON) PLOAM event, the ONU has discretion to exercise any power management mode including doze or sleep mode, which would in no way preclude the ONU from alternating between a doze mode and a sleep mode as described in Röger. Ex. 1006, 6-8, 10-13; Ex. 1007, 10, 97-106; Ex. 1003, ¶74. An ONU of G.987.3 would be operable to directly transition back and forth as shown in Röger because the ONU of Röger would be standardized based on ITU-T recommendations. The ONU would alternate between sleep and doze modes, occasionally waking up to an Aware state identical to DozeAware or SleepAware (i.e., both have a transmitter and receiver turned on), allowing the ONU to transition between the Asleep and Listen states would not impact these functions of the ONU. Ex. 1007, 100-102; Ex. 1003, ¶74.”

Petition

MOTIVATION TO COMBINE

“Regardless, it was well known as of the effective filing date of the ’892 Patent for an ONU to directly transition between two low power states. Specifically, Röger teaches that ONUs may transition directly back and forth between the first low power state and the second low power state as part of a “low-energy” protocol which allows efficient use of the optically provided energy transmitted to optical network units. Ex. 1006 (Röger), 6-8, 10-13. This “low-energy” protocol allows an optical network unit to nearly periodically listen for signals from an optical line terminal without wasting power by turning on their transmitters. Ex. 1006 (Röger), 6-8, 10-13. If the optical network unit receives a signal indicating a rendezvous time at which to communicate with the optical line terminal, the optical network unit continues to save the most power possible by snoozing until the rendezvous time. Ex. 1006 (Röger), 6-8, 12.”

Ex. 1003, Sergienko Declaration

MOTIVATION TO COMBINE

“Given this well-known improvement to electronic chip and circuits technology, a POSITA would have been motivated to apply the direct transitions between sleep and receive states from Röger to G.987.3 because Röger specifically states that its protocol allows ONUs to operate with “the least possible power consumption” to “save both energy and communication bandwidth.” Ex. 1006, 6-7; Ex. 1003, ¶73. Saving energy and communication bandwidth allows the PONs to perform their functionality with more efficiency. Ex. 1003, ¶73.”

Petition

MOTIVATION TO COMBINE

“A POSITA would have been motivated to apply these direct transitions to the optical network units of G.987.3 in view of the known advancements in technology at the time. Advancements in chip speed that occurred prior to the priority date of the '892 Patent made it more practical to periodically turn on and off a receiver while a transmitter remained off in an ONU. In particular, a POSITA would have been motivated to apply the direct transitions of Röger in light of advancements in how fast a receiver could be switched on from a sleep mode. Periodically turning on a receiver was previously less efficient due to a slower continuous mode (CM) clock and data recovery (CDR) time of 2-5 milliseconds for each RxOn event for earlier electronic circuits. Ex. 1011 (Wong), 3-4.

. . .

This improvement to electronic chip and circuits technology also reduced the attractiveness of leaving an ONU in a receive-only state since additional power could be saved by periodically switching the receiver off without causing significant delay during transition.”

Ex. 1003, Sergienko Declaration

MOTIVATION TO COMBINE

(ii) Technology Advancements

As discussed above, Petitioner set forth various technology advancements that it contends were made before the filing of the '982 patent that made it easier for an ordinarily skilled artisan to take advantage of known energy savings by incorporating the direct transitions of Röger into G.987.3. Pet. 12–14. These arguments are supported by expert testimony, which in turn has non-testimonial evidentiary support. *Id.*; Ex. 1003 ¶¶ 70–74; Ex. 1011, 3–4; Ex. 1006, 5–7. Patent Owner's contrary argument is supported by expert testimony, but that expert testimony does not cite non-testimonial evidentiary support and is conclusory regarding why the advancements would not motivate an ordinarily skilled artisan to modify G.987.3. Prelim. Resp. 26–27; Ex. 2001 ¶ 51. Thus, on the current record, Petitioner's argument regarding the motivation resulting from technology advances is more persuasive. At trial, however, additional exposition could be beneficial on the issues of technology advances, their effects on an ordinarily skilled artisan's motivation, and energy reduction.

Institution Decision

MOTIVATION TO COMBINE

¶111. *Fifth*, Petitioners argue that G.987.3 would implement their advocated direct transition in view of Röger because “[a]dvancements in chip speed . . . made it more practical to periodically turn on and off a receiver while a transmitter remained off in an ONU.” Corrected Petition at 12–13. Implicit in Petitioners’ argument is that the reason G.987.3 disallowed transitions from the Asleep to Listen states was that G.987.3 viewed the time it took to turn on a receiver as unacceptable. I disagree.

¶112. The speed of receiver turn-on as suggested by the Petitioners in referencing Röger was simply not a concern. This is evident as G.987.3 already allows for direct transitions from the Cyclic Sleep-Asleep state (RX off and TX off) to Cyclic Sleep- Sleep Aware state (RX on and TX on) and also allows direct transitions from the Cyclic Sleep-Asleep state to the Active Held State (RX on and TX on). This shows that at the time of G.987.3 (Ex1007), transceiver, receiver, and transmitter turn-on times were not of concern. See figure 16-1 ONU state transition diagram (Ex. 1007 at 101) and table 16-2 ONU power management states (Ex. 1007 at 100).

Ex. 2007, Litvin Dec.

MOTIVATION TO COMBINE

Question(s):	Q2	Meeting, date:	May 23, 2013, Chengdu
Study Group:	15	Working Party:	1
		Intended type of document (R-C-TD):	C
Source:	Futurewei		
Title:	Proposed Revisions for simplifying power saving modes in G.987.3		
Contact:	Frank Effenberger	Tel :	
	Futurewei Technologies	Fax :	
	U.S.	Email :	

Another point to account for is the current progress of transmitter driver technology. Chips are now commercially available that offer very fast enable/disable times. The Maxim MAX3643 gives 5.5us enable and 0.375 us disable times. The Micrel SY88216 gives a 10us enable time. The Mindspeed M02069 can enable and disable in 1us. This makes dozing far less attractive, as the ONU can turn off its transmitter even during normal operation. For this reason, we aim to deprecate dozing as stand-alone mode or feature.

Ex. 1040, ITU Contribution D72

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MOTIVATION TO COMBINE

Additionally, G.987.3, G.988, and Röger disclose ONUs operating in a first state where a receiver is on and a transmitter is off and a second state where both the receiver and transmitter are off. Ex. 1006, 598, 11-12; Ex. 1007, 100-102; Ex. 1008, 81; Ex. 1003, ¶68. G.987.3 and Röger specifically suggest that these modes allow the ONUs to save power and address transitions between power states. Ex. 1006, 6-8, 10-13; Ex. 1007, 97-106; Ex. 1003, ¶68. G.987.3, however, does not explicitly

Regardless, it was well known as of the effective filing date of the '892 Patent for an ONU to directly transition between two low power states to save power. Ex. 1003, ¶71. Specifically, Röger teaches that ONUs may transition directly back and forth between the first state and the second state as part of a “low-energy” protocol, allowing efficient use of energy transmitted to ONUs. Ex. 1006, 6-8, 10-13; Ex. 1003, ¶71. This “low-energy” protocol allows an ONU to periodically listen for signals from an OLT without wasting power by turning on their transmitters. Ex. 1006, 6-8, 10-13; Ex. 1003, ¶71.

It would have been obvious to the POSITA to allow for direct transitions between a first state (e.g., Listen mode) and a second state (e.g., Asleep mode). Ex. 1003, ¶70. This modification to direct transitions would have been driven by a well-known problem in the field, reducing power consumption. Ex. 1003, ¶70. G.987.3

Petition

MOTIVATION TO COMBINE

¶109. With regard to the number of possible power states that the ONU receiver and transmitter could theoretically take on in the scenario of power savings and data communications each could be: a) continually on or b), continually off or c) cycled on and off. This leads to nine possibilities. Considering power efficiency, one would immediately disregard the three combinations where the transmitter is continually on. Considering link connectivity, one would also disregard any combination where the receiver is continually off. This leaves four potential candidates: A) receiver always on & transmitter always off, B) receiver always on & transmitter cycled on/off, C) receiver cycled on/off & transmitter always off, D) receiver cycled on/off & transmitter cycled on/off. The Doze mode corresponds to B, the Cyclic Sleep mode corresponds to D, and the patent claim states corresponds to C.

Ex. 2007, Litvin Dec.

MOTIVATION TO COMBINE

Table 16-7 – OLT state transition and output table

NOTE 2 – Direct transitions between Doze mode and Cyclic Sleep mode are disallowed. When the OLT receives a request to execute such a transition, it attempts to regain state machine synchronization by waking up the ONU. The transitions are not shown on the diagram for the sake of compactness.

Table 16-7 – OLT state transition and output table

Inputs	OLT power management states					
	(1) Awake Forced	(2) Awake Free	(3) Low Power Sleep	(4) Alerted Sleep / FWI	(5) Low Power Doze	(6) Alerted Doze / FWI
SR (Awake)	*	*	→ (2)	→ (1)	→ (2)	→ (1)
SR (Sleep)	* /SA(OFF) (Note 1)	→ (3)	*	*	→ (1) /SA(OFF) (Note 2)	→ (1) /SA(OFF) (Note 2)
SR (Doze)	* /SA(OFF) (Note 1)	→ (5)	→ (1) /SA(OFF) (Note 2)	→ (1) /SA(OFF) (Note 2)	*	*
Allocation miss	*	→ (1) /SA(OFF)	*	*	*	*
OLT-LWI ON	*	→ (1) /SA(OFF)	→ (4) /SA(OFF)	*	→ (6) /SA(OFF)	*
OLT-LWI OFF	→ (2) /SA(ON)	*	*	(Note 3)	*	(Note 3)
Tarried exp.				→ (1)		→ (1)
Ter exp.			→ (1) /SA(OFF)		→ (1) /SA(OFF)	

NOTE 1 – An exception from the subgraph rule, an output may help to stabilize the state machine in case the condition is caused by a lost SA(OFF) message. The output is not shown on the FSM diagram.

NOTE 2 – Direct transitions between Doze mode and Cyclic Sleep mode are disallowed. When the OLT receives a request to execute such a transition, it attempts to regain state machine synchronization by waking up the ONU. The transitions are not shown on the diagram for the sake of compactness.

NOTE 3 – This is a situation when the OLT initiates a wake-up, but the OLT-LWI is cleared before the ONU is awoken. In this case, the OLT, instead of cancelling the wake-up process and attempting to immediately revert to a low power state, insists on waking the ONU up with the intent to re-enter a low power state via states AwakeForced and AwakeFree.

Ex. 1007, Prior Art G.987.3

MOTIVATION TO COMBINE

Table 16.7 – OLT state transition and output table

NOTE 2 – Direct transitions between Doze mode and Cyclic Sleep mode are disallowed. When the OLT receives a request to execute such a transition, it attempts to regain state machine synchronization by waking up the ONU. The transitions are not shown on the diagram for the sake of compactness.

Table 16.7 – OLT state transition and output table

Inputs	OLT power management states					
	(1) Awake/Free	(2) Awake/Free	(3) LowPower Sleep/Watch	(4) Alerted Sleep/Watch FWI	(5) LowPower/Doze	(6) Alerted/Doze FWI
SR (Awake)	*	*	→ (2)	→ (1)	→ (2)	→ (1)
SR (Sleep/WSleep)	→ (1) /SA(OFF) (Note 1)	→ (1)	*	→ (1) /SA(OFF) (Note 2)	→ (1) /SA(OFF) (Note 2)	→ (1) /SA(OFF) (Note 2)
SR (Doze)	→ (1) /SA(OFF) (Note 1)	→ (5)	→ (1) /SA(OFF) (Note 2)	→ (1) /SA(OFF) (Note 2)	*	*
Allocation miss	*	→ (1) /SA(OFF)	*	*	*	*
OLT-LWT ON	*	→ (1) /SA(OFF)	→ (4) /SA(OFF)	*	→ (6) /SA(OFF)	*
OLT-LWT OFF	→ (2) /SA(ON)	*	*	(Note 3)	*	(Note 3)
Tolerated expiration			→ (1)		→ (1)	→ (1)
Terminated expiration			→ (1) /SA(OFF)		→ (1) /SA(OFF)	

* Indicates a self-transition.
 (Note 1) A shaded cell means that the input is not applicable in the given state.
 NOTE 1 – An exception from the subgraph rule; an output may help to stabilize the state machine in case the condition is caused by a lost SA(OFF) message. The output is not shown on the FSM diagram.
 NOTE 2 – Direct transitions between Doze mode and Cyclic Sleep mode are disallowed. When the OLT receives a request to execute such a transition, it attempts to regain state machine synchronization by waking up the ONU. The transitions are not shown on the diagram for the sake of compactness.
 NOTE 3 – This is a situation when the OLT initiates a wake-up, but the OLT-LWT is cleared before the ONU is woken. In this case, the OLT, instead of cancelling the wake-up process and attempting to immediately revert to a power saving, insists on waking the ONU up with the intent to re-enter a power saving state via states Awake/Free and Awake/Free.

C.16.1.4 Management transactions in the LowPower state
 The ONU can receive and act on downstream management traffic at any of the three channels described in clause C.6.1.4, except when it is in its LowPower state and has its receiver switched off. The OLT is responsible for understanding when the ONU can be expected to receive downstream management traffic, or to deal with the possibility that the ONU does not receive such traffic.
 If the ONU receives embedded OAM commands such as DBRu or PLOAMu when it cannot respond immediately, i.e. when it is in a LowPower state but has its receiver powered on, it ignores the commands. It is the OLT's responsibility to allow for extra response delays if it sends PLOAM or OMCI commands to an ONU that may be incapable of responding within the normal time.
 It is prudent for the OLT to force the ONU awake before conducting management transactions.

Ex. 1010, Accused Infringing G.9807.1

MOTIVATION TO COMBINE

Question(s):	Q2	Meeting, date:	<u>Conference call, March 31, 2010</u>
Study Group:	15	Working Party:	1
		Intended type of document (R-C-TD):	C
Source:	Editors		
Title:	Editorial Summary: XG-PON Transmission Convergence layer specification / Clause 16		

Introduction

This document presents the editorial notes on the two XG-PON power management contributions submitted for consideration during the March 31 conference call

In addition, the following has been previously agreed during the San Francisco face-to-face meeting

The June 2010 version of G.987.3 SHALL contain a specification of **dozing mode** as a MANDATORY to implement feature that ensures that an ONU can be periodically put to doze so that Tx, but NOT Rx, can be turned off, along with certain other functions. At the time the SFO decision was taken, the description of the doze mode had been long stable per G.Sup49.

Two texts have been submitted for consideration: a contribution by Jeff Mandin and Hiroaki Mukai [PMC-MITS] and a contribution by Sam Sambasivan, Dave Eckard, and Dave Hood [ATT-ALU-ERIC].

Ex. 1037, ITU Contribution D5

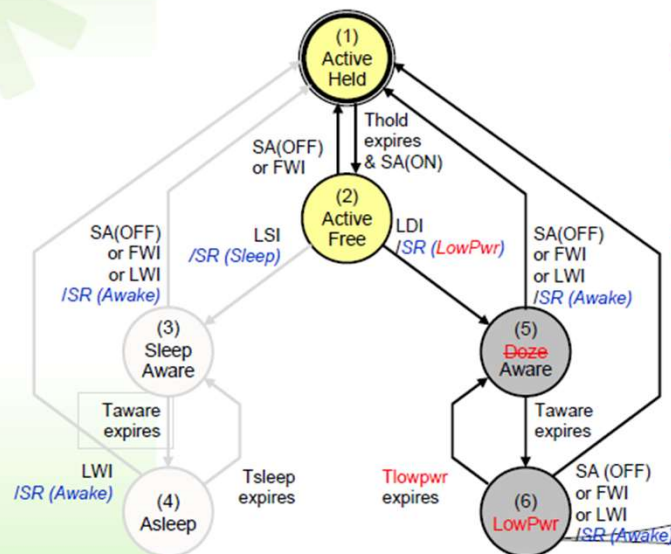
MOTIVATION TO COMBINE

The appropriate question is not whether a POSITA could readily integrate every aspect of the Röger system into G.987.3 as “[i]t is well-established that a determination of obviousness based on teachings from multiple references does not require an actual, physical substitution of elements.” *In re Mouttet*, 686 F.3d 1322, 1332-33 (Fed. Cir. 2012); *In re Sneed*, 710 F.2d 1544, 1550 (Fed. Cir. 1983) (“[I]t is not necessary that the inventions of the references be physically combinable to render obvious the invention under review.”). In *Mouttet* the court explained that an

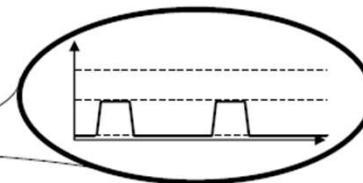
Petitioners’ Reply

MOTIVATION TO COMBINE

What should be done



- Reusing mandatory branch of G.987.3!
- A change to the internal state semantics , not to the protocol
- A transition out of Low Power state is present!
- Since only one branch is left, does not matter whether it is called Sleep or Doze: it is Unified mode!



Ex. 1040, ITU Contribution D8

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MOTIVATION TO COMBINE [[cmpat]]

Conclusions

- It does NOT matter which half of the state machine is deprecated and how the states are called
 - As long as the critical transitions are present and backward compatibility is maintained
- In the current G.987.3, Doze mode is mandatory, Cyclic Sleep is optional
- The former Doze branch provides the necessary transition from LowPower to the ActiveHeld on external wakeup stimulus
- For the specification details, see D75 in Chengdu

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Ex. 1040, ITU Contribution D8

MOTIVATION TO COMBINE

4.1 Impact on the state machines

As the Unified mode of ONU power management brings two previously defined power management modes under a single parametric framework, it naturally simplified the implementation. Furthermore, the Mode state machines can be derived as a reduction of the two-mode state machines currently specified in G.987.3. In both the OLT and ONU cases, one of the branches can be eliminated, and the number of codepoints to distinguish between two modes, reduced.

Ex. 1041, ITU Contribution D75

MOTIVATION TO COMBINE

4.2 Parameter definitions

The Table below contains the essential configurable timing parameters for the Unified mode of the ONU power management, emphasizing the differences with the base G.987.3 specification.

Parameter	Description	Defined by	Known to
~~lloppower~~	~~lloppower is the maximum time the ONU spends away from the Aware state, as a count of 125 microsecond frames. Local wake-up indications (LWIs) or remote events may truncate the ONU's sojourn in these states.~~	~~OLT~~	~~ONU, OLT~~
~~tlowpower~~	~~Local timer at ONU. Upon leaving the Aware state the ONU initializes Tlowpower to a value equal to or less than lloppower.~~	~~ONU~~	~~ONU~~
~~Isleep~~	~~Isleep is the maximum time the ONU spends in its Asleep or Listen states, as a count of 125 microsecond frames. Local wake-up indications (LWIs) in both Asleep and Listen states or remote events in Listen state may truncate the ONU's sojourn in these states.~~	~~OLT~~	~~ONU, OLT~~
~~Tsleep~~	~~Local timer at ONU. Upon entry to Asleep state, the ONU initializes Tsleep to a value equal to or less than Isleep. Secondary internal timers may be required to guarantee that the ONU will be fully operational when it enters aware state after an interval not to exceed Isleep.~~	~~ONU~~	~~ONU~~
~~laware~~	~~laware is the minimum time the ONU spends in its Aware state before transitioning to a low power state (Asleep or Listen), as a count of 125 microsecond frames. During the laware interval, local or remote events may independently cause the ONU to enter the ActiveHeld state rather than returning to a low power state.~~	~~OLT~~	~~ONU, OLT~~
~~Taware~~	~~Local timer at ONU, initialized to a value equal to or greater than laware once downstream synchronization is obtained upon entry to Aware state. Taware controls the dwell time in aware state before the ONU re-enters one of the low power states.~~	~~ONU~~	~~ONU~~
~~ltransinit~~	~~Complete transceiver initialization time: The time required for the ONU to gain full functionality when leaving the Asleep state (i.e., turning on both receiver and transmitter), measured in units of 125 us PHY frames, and known by design. The value of zero indicates that the sleeping ONU can respond to a bandwidth grant without delay.~~	~~ONU~~	~~ONU, OLT~~
~~ltxinit~~ ~~Obsolete~~	~~Transmitter initialization time: the time required for the ONU to gain full functionality when leaving the Listen state (i.e., turning on the transmitter while the receiver has remained on), measured in units of 125 us PHY frames. The value of zero indicates that the dozing ONU can respond to a bandwidth grant without delay.~~	~~ONU~~	~~ONU, OLT~~

Talerted	Local timer to bound the time that the OLT state machine remains in an alerted state before entering the AwakeForced state. If the ONU that the OLT attempts to wake up has been sleeping, Talerted should be initialized to at least Isleep + ltransinit + round-trip delay + tolerances for Rx synchronization, bandwidth grant irregularities, and processing time. ~~If the ONU that the OLT attempts to wake up has been dozing, Talerted should be initialized to at least ltxinit + round-trip delay + tolerances for bandwidth grant irregularities and processing time.~~	OLT	OLT
Clobi	Counter of missing upstream bursts in OLTs AwakeForced(i) state for loss of signal defect for ONU i. If Clobi expires, the OLT declares LOBi against ONU i.	OLT	OLT
Teri	Local handshake timer at the OLT that defines the latest instant at which an upstream burst is expected from sleeping or dozing ONU i. The OLT reinitializes and starts this timer when the OLT's state machine for the given ONU transition into the LowPower state and each time an upstream burst is received from the ONU while in that state. If Teri expires, the OLT declares a handshake violation and attempts to force the ONU awake. To determine the initial value of Teri, the OLT is responsible to consider the provisioned Isleep interval and any possible effects of transceiver initialization, synchronization, and irregularities in the bandwidth grant cycle.	OLT	OLT
lhold	Minimum sojourn in the ActiveHeld state.	OLT	ONU, OLT
Thold	Local timer at the ONU that is initialized to lhold upon transmission of SR(Awake) after entry into ActiveHeld state and that enforces the minimum sojourn in the ActiveHeld state.	ONU	ONU

Ex. 1041, ITU Contribution D75

MOTIVATION TO COMBINE

Table 16-1 – Power management parameters

Parameter	Description	Defined by	Known to
Isleep	Isleep is the maximum time the ONU spends in its Asleep or Listen states, as a count of 125 microsecond frames. Local wake-up indications (LWIs) in both Asleep and Listen states or remote events in Listen state may truncate the ONU's sojourn in these states.	OLT	ONU, OLT

Ex. 1007, G.987.3

Table C.16.1 – Power management parameters

Parameter	Description	Defined by	Known to
llowpower	llowpower is the maximum time the ONU spends in a LowPower state (i.e., Asleep, Listen or Watch state), as a count of 125 microsecond frames. Local wake-up indications (LWIs) or remote events, if detected, may truncate the ONU's sojourn in these states.	OLT	ONU, OLT

Ex. 1005, PO Infringement Contentions

MOTIVATION TO COMBINE

Chart Detailing AT&T's Infringement of U.S. Patent No. 9,806,892

Iarnach Techs. v. AT&T Corp., et al., Case No. 2:23-cv-0231-JRG (E.D. Tex.)

Chart Detailing AT&T's Infringement of U.S. Patent No. 9,806,892

Iarnach Techs. v. AT&T Corp., et al., Case No. 2:23-cv-0231-JRG (E.D. Tex.)

The Accused Instrumentalities include all components necessary for AT&T to provide fiber-optic networks and network services to its customers, including all hardware and software, optical line terminals (OLTs), and optical network units (ONUs)/optical network terminals (ONTs). This includes both residential and commercial customers, as well as fiber used in AT&T's wireless backhaul.

Based on the information presently available to it, Plaintiff Iarnach Technologies Limited ("Iarnach" or "Plaintiff") is informed and believes that AT&T directly and indirectly infringes U.S. Patent No. 9,806,892 (the "'892 Patent"). AT&T directly infringes claims 1, 2, 3, and 5 of the '892 Patent when it makes, uses, sells, and/or imports the Accused Instrumentalities. AT&T indirectly infringes claims 1, 2, 3, and 5 of the '892 Patent by actively inducing the direct infringement of its customers; AT&T actively induces its customers to use the Accused Instrumentalities.

CLAIM 1	'892 PATENT V. AT&T
I[A]. A method of optical communication in a passive optical network, comprising:	The Accused Instrumentalities implement a method of optical communication in a passive optical network. AT&T began deploying fiber internet to homes and businesses in approximately 2010. https://about.att.com/innovationblog/2022/20-gbps-symmetric-speeds.html (last visited April 24, 2023). AT&T's original fiber-based networks implemented Gigabit Passive Optical Networking (GPON) technology. <i>Id.</i> In 2020, AT&T began deploying an XGS-PON system. AT&T describes itself as "an early adopter of XGS-PON with the largest deployment in North America." <i>Id.</i> AT&T states that "with XGS-PON, we increased our network fiber capacity by 4x in the downstream and 8x in the upstream at roughly the same economics as our prior GPON investment." <i>Id.</i>

Ex. 1005, PO Infringement Contentions

This clause addresses three additional means of power management, which does require TC layer support. One is called **Doze mode**; another is referred to as **Cyclic sleep mode**; the third is known as **Watchful sleep mode**. The Watchful sleep mode combines the semantic features of the Doze and Cyclic sleep modes while reusing the states and transition of the Doze mode on the ONU side, and those of the Cyclic sleep mode on the OLT side. To support XG-PON ONUs, the XGS-PON OLT must support all three modes. For XGS-PON ONU, only the Watchful sleep mode needs to be supported.

The TC-layer supported ONU power management modes are negotiated via OMCI, and may be combined with any of the other power reduction techniques.

G.9807.1 at 219

In Supplement 45 (09/2022) to its G series recommendations, the ITU defines the power saving modes mentioned above in G.9807. See G series - Supplement 45 (09/2022) [hereinafter "Supp. 45"] at 20.

When in Doze mode, the ONU powers off the transmitter while the receiver remains on:

ONU Doze (Dozing) is associated with additional powering off of the ONU Tx for substantial periods of time on the condition that the Rx remains continuously on. Note the ITU-T recommendations adopted "Doze" mode instead of "Dozing".

Supp. 45 at 20.

The Doze mode is also a component of the Watchful Sleep mode:

ONU Watchful Sleep mode collapsing Dozing and Cyclic Sleep in a single state machine has been specified and adopted as replacement since the introduction of XG-PON.

Supp. 45 at 20.

The time during which the Doze state is active within Watchful sleep comprises a first state in which the transmitter of the ONU is turned off and a receiver of the ONU is turned on.

ROADMAP

- 01 | Overview of the Challenged Patent
- 02 | Overview of the Disputes
- 03 | Claim Construction
- 04 | Combination & Motivation to Combine
- 05 | Challenges to Motivation to Combine Fail
- 07 | Claim 4**
- 08 | Claim 12
- 09 | Claim 15

Claim 4

1. A method of optical communication in a passive optical network, comprising:

operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on;

operating the ONU in a second state in which both the transmitter and the receiver are turned off;

transitioning the ONU directly from the first state to the second state and transitioning the ONU directly from the second state to the first state, based on a power management rule;

ensuring the ONU is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control before exiting the first state or the second state; and

receiving, by the receiver, a power management message from an optical line terminal (OLT); and

changing the power management rule based on the received power management message.

4. The method of claim 1, further comprising:

transmitting, to an optical line terminal, a message indicative of the transitioning between the first state and the second state.

Claim 4

11.3.2 Upstream message summary

Table 11-3 summarizes the upstream messages.

Table 11-3 – Upstream messages

Message ID	Message name	Function	Trigger	Effect of receipt
0x10	Sleep_Request	To signal the ONU's intention to change power saving modes.	Under state machine control.	Defined in clause 16.

Ex. 1007, G.987.3

Claim 4

Table 16-4 – ONU state transition and output table

Inputs	ONU power management states					
	(1) ActiveHeld	(2) ActiveFree	(3) SleepAwake	(4) Asleep	(5) DozeAware	(6) Listen
FWI	*	→ (1)	→ (1) <u>/SR(Awake)</u>		→ (1) <u>/SR(Awake)</u>	→ (1) <u>/SR(Awake)</u>
SA (OFF)	*	→ (1)	→ (1) <u>/SR(Awake)</u>		→ (1) <u>/SR(Awake)</u>	→ (1) <u>/SR(Awake)</u>
SA (ON)	→ (2) Upon Thold exp. (Note)	*	*		*	*
LWI	*	*	→ (1) <u>/SR(Awake)</u>	→ (1) <u>/SR(Awake)</u>	→ (1) <u>/SR(Awake)</u>	→ (1) <u>/SR(Awake)</u>
LSI		→ (3) <u>/SR(Sleep)</u>	*	*		
LDI		→ (5) <u>/SR(Doze)</u>			*	*
Tsleep exp.				→ (3)		→ (5)
Taware exp.			→ (4)		→ (6)	

Ex. 1007, G.987.3

Claim 4

NOTE 2 – Direct transitions between Doze mode and Cyclic Sleep mode are disallowed. When the OLT receives a request to execute such a transition, it attempts to regain state machine synchronization by waking up the ONU. The transitions are not shown on the diagram for the sake of compactness.

Ex. 1007, G.987.3

ROADMAP

- 01 | Overview of the Challenged Patent
- 02 | Overview of the Disputes
- 03 | Claim Construction
- 04 | Combination & Motivation to Combine
- 05 | Challenges to Motivation to Combine Fail
- 07 | Claim 4
- 08 | Claim 12**
- 09 | Claim 15

Claim 12

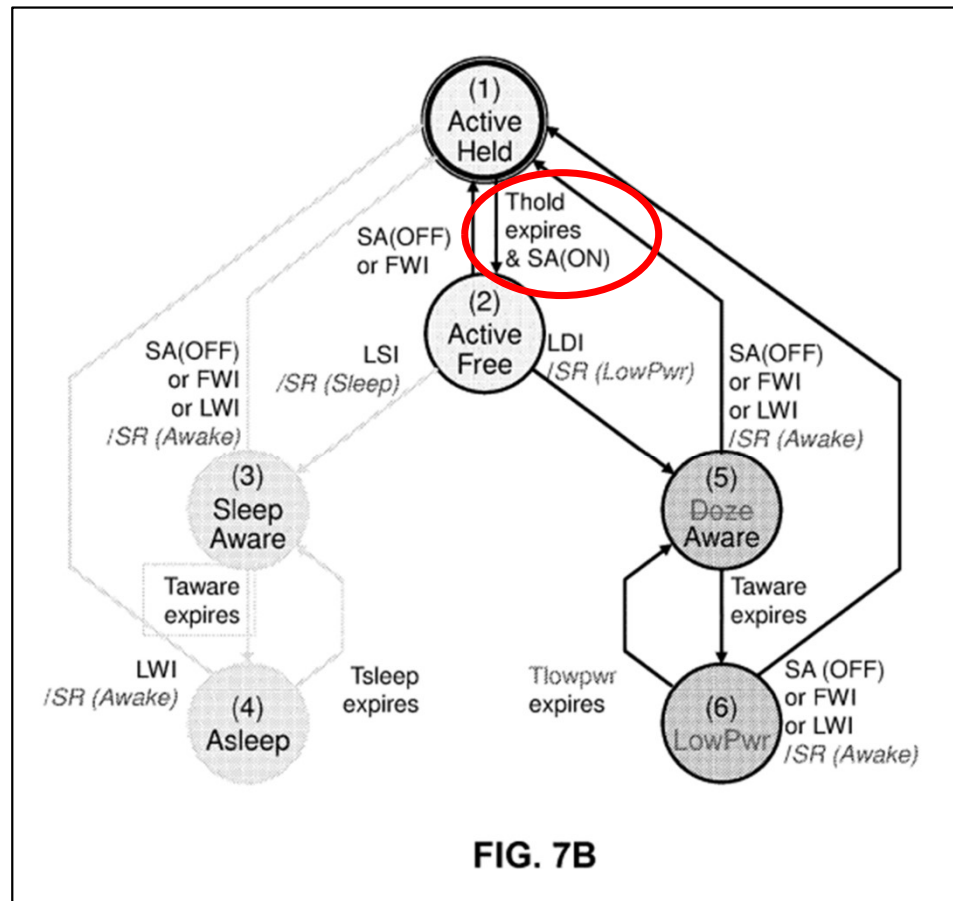
12. An optical line terminal (OLT) for operation in a passive optical network (PON), the optical line terminal comprising:

a processor configured to generate messages for controlling a transition of an optical network unit from a first low power state in which a receiver of the optical network unit is turned on but a transmitter of the optical network unit is turned off to a second low power state in which both the receiver and the transmitter of the optical network unit are turned off;

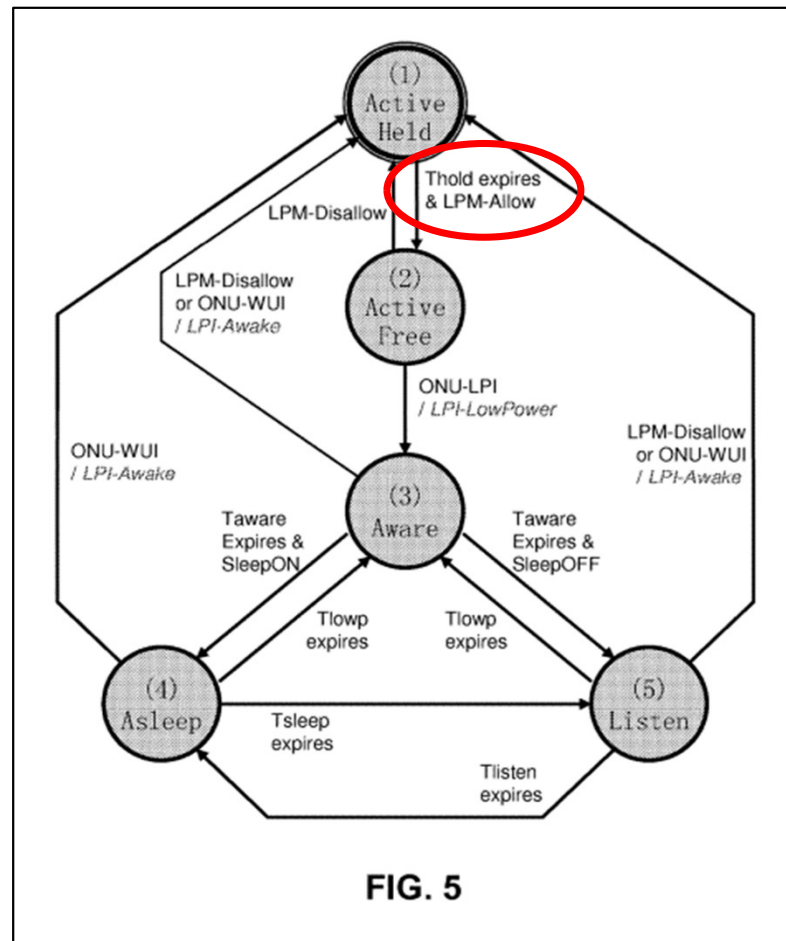
a transmitter configured to transmit the generated messages to the optical network unit;

wherein the generated messages comprises a periodic consent message to allow the optical network unit to remain in either the first low power state or the second low power state.

Claim 12



Claim 12



Claim 12

12. An optical line terminal (OLT) for operation in a passive optical network (PON), the optical line terminal comprising:

a processor configured to generate messages for controlling a transition of an optical network unit from a first low power state in which a receiver of the optical network unit is turned on but a transmitter of the optical network unit is turned off to **a second low power state in which both the receiver and the transmitter of the optical network unit are turned off**;

a transmitter configured to transmit the generated messages to the optical network unit;

wherein the generated messages comprises a periodic consent message to allow the optical network unit to remain in either the **first low power state** or **the second low power state**.

An ONU in the second low power state
cannot receive *any* message.

ROADMAP

- 01 | Overview of the Challenged Patent
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- 05 | Challenges to Motivation to Combine Fail
- 07 | Claim 4
- 08 | Claim 12
- 09 | Claim 15**

Claim 15

14. A passive optical network (PON) communications system, comprising: . . .

wherein the ONU is configured to transition from the first low power mode to the second low power mode and to transition from the second low power mode to the first low power mode based on a **power management rule**, and wherein the ONU changes a power management rule based on a received power management message;

an optical line terminal (OLT) communicably coupled to the ONU, the OLT configured to transmit a **control message** to the ONU to control at least one aspect of transition of the ONU between the first low power mode and the second low power mode; . . .

15. The system as in claim 14, wherein: the OLT is configured to transmit **the control message** that includes the **power management rule** that specifies a first time period for operation in the first low power state and a second time period for operation in the second low power state and to control the ONU to transition from the first low power state to the second low power state upon expiration of at least one of the first time period and the second time period.

Claim 15

1: A method of optical communication in a passive optical network, comprising: . .

receiving, by the receiver, **a power management message** from an optical line terminal (OLT); and

changing the **power management rule based on the received power management message**.

3. The method of claim 1, wherein the **power management rule** specifies a first time period . . . and a second time period . . .

14. A passive optical network (PON) communications system, comprising: . . .

wherein the ONU is configured to transition . . . based on **a power management rule**, and wherein the ONU changes a power management rule based on a received power management message; . . .

the OLT configured to transmit **a control message** to the ONU to control at least one aspect of transition of the ONU between the first low power mode and the second low power mode; . . .

15. The system as in claim 14, wherein: the OLT is configured to transmit **the control message** that includes the **power management rule** that specifies a first time period . . . and a second time period

Claim 15

3. The method of claim 1, wherein
the power management rule specifies

a first time period for operation in the first
state and

a second time period for operation in the
second state and

wherein the transitioning is performed upon
expiration of at least one of the first time
period and the second time period.



15. The system as in claim 14, wherein:

the OLT is configured to transmit **the control message** that includes the **power management rule** that specifies

a first time period for operation in the first low
power state and

a second time period for operation in the second
low power state and

to control the ONU to transition from the first low
power state to the second low power state upon
expiration of at least one of the first time period
and the second time period.

PO does **not** argue that Claim 3 is not disclosed by G.987.3.

Claim 15

82; Ex. 1003, ¶110. Isleep teaches the “first time period” by specifying the maximum time the ONU may spend in its Listen state (“first state”). Ex. 1007, 99. When the local timer is set to its maximum value, the ONU transitions from the Listen state (“first state”) at the expiration of Isleep. Ex. 1007, 98; Ex. 1003, ¶110. Isleep teaches the “second time period” by specifying the maximum time the ONU may spend in its Asleep state (“second state”). Ex. 1007, 98; Ex. 1003, ¶110. When the local timer is set to its maximum value, the ONU transitions from the Asleep state (“second state”) at the expiration of Isleep. Ex. 1007, 98; Ex. 1003, ¶110. Thus, Isleep teaches both the first time period and the second time period. Ex. 1003, ¶110.

PO does **not** argue that Claim 3 is not disclosed by G.987.3.

END

Röger

