Exhibit A

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Girard

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(54) **DISTRIBUTED EDGE SWITCHING SYSTEM FOR VOICE-OVER-PACKET MULTISERVICE NETWORK**

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H04L 12/66 (2006.01)
H04L 12/28 (2006.01)
H04L 12/56 (2006.01)
H04J 1/02 (2006.01)

(52) **U.S. Cl.** **370/353**; 370/356; 370/401; 370/493

(58) **Field of Classification Search** 370/352, 370/353, 355, 356, 384, 395.2, 401, 410, 370/466, 467; 709/226, 229, 240; 725/117, 725/119, 131
See application file for complete search history.

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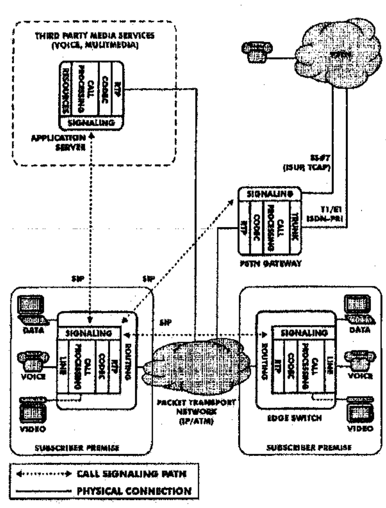
(57) **ABSTRACT**

A network device including a plurality of communication interfaces, including a telephone line interface, a computer data interface, and a broadband network interface; a processor; a machine-readable storage medium which during use stores a call processing application and service profiles, and which stores executable instructions to mediate communications between the plurality of communication interfaces, the instructions causing the network device to detect network signaling events or trigger points in a telephone call and invoke the call processing application in response to the detected network signaling events or trigger points, the call processing application operating according to parameters defined in the service profiles.

19 Claims, 13 Drawing Sheets



DISTRIBUTED EDGE SWITCHING SYSTEM FOR VOICE-OVER-PACKET MULTISERVICE NETWORK

RELATED APPLICATION

This application claims priority to U.S. provisional application 60/283,888 filed on Apr. 13, 2001, the contents of which are incorporated herein by reference.

TECHNICAL FIELD

This invention relates to packet networks, and more particularly to network devices.

BACKGROUND

This section contains a discussion of background. It summarizes telecommunications carrier network architectures that currently exist as legacy or that are currently under development. It also includes discussion of insights and observations made by the inventor about the prior art systems that are helpful to understanding the subsequently described invention but that were not necessarily appreciated by persons skilled in the art or disclosed in the prior art. Thus, the inclusion of these insights and observations in this background section should not be interpreted as an indication that such insights and observations were part of the prior art. After the background discussion, a new Edge Switched Network (ESN) architecture is introduced and it is described and compared to leading "Next Generation Network" alternatives. A Distributed Edge Switch (DES) makes possible the implementation of an ESN. In the OVERVIEW section that is found in the Detailed Description section, the design, operation and management of the DES are described within the architectural context provided by the ESN.

Next Generation Networking Approaches

In recent years, attempts to transform the legacy Public Switched Telephone Network (PSTN) to exploit the potential of the Internet has led to approaches that are loosely referred to as the Next Generation Network (NGN). It was believed that such approaches would lead to converged networks. Converged networks promise substantial cost savings and new service opportunities for telecommunications carriers (a.k.a. "carriers," or "network service providers"). As a means to realize new data services, carriers have deployed overlay networks, which require overlay of new infrastructure onto existing legacy voice networks. In contrast, the converged approach of the NGN seeks to eliminate the need to have separate networks for different media. It exploits the principles of "openness" and leverages the standard protocols of IP networks to carry not only data but also other media such as voice and video.

The PSTN and AIN Principles

The NGN grew out of the PSTN, thus to understand its origins one must understand present day Advanced Intelligent Network (AIN) employed by PSTN carriers to provide advanced telephony services. The AIN was proposed as the solution to the carriers' needs to produce applications rapidly and independently of switch development efforts. Prior approaches had bundled services within switches, giving rise to long development times and inflexible service deployment. Service development and deployment was intimately tied to switch evolution and switch development cycles.

AIN proposed de-coupling service development and service logic from switches by building appropriate trigger

points within the switch. Upon encountering a trigger detection point while processing a call, the switch, called the Service Switching Point (SSP), would trigger and send a query to a Service Control Point (SCP). FIG. 1 illustrates the elements of AIN. The SSP performs a query directed to an SCP. The SCP executes service logic that yields a result and that result is returned to the SSP that initiated the query. The SSP then continues with call processing.

As an example, when a subscriber dials an 800 number, an SSP detects that the call requires AIN service logic processing. The SSP directs a query to an SCP which in turn executes service logic that returns a valid dialing number to the SSP. The SSP then asks the Signaling System #7 (SS#7) network to set-up a call to that telephone number. SS#7 sets up signaling and bearer paths necessary to support a call to that dialing number. The CENTRAL OFFICE SWITCH serving the called party applies a ringing tone to the called party's telephone. Once the called party answers, the call is established and both the parties can now have a telephone conversation.

FIG. 1 depicts the structure of the PSTN, including its support for AIN. The CENTRAL OFFICE SWITCH is decomposed into four distinct modules:

CALL PROCESSING
LINE
SIGNALING
TRUNK

The LINE module functions include detecting on-hook/off-hook, applying dial tone and ringing tone, collecting dialed digits, and communicating internally with the call-processing module. The CALL PROCESSING module analyzes the digits collected by the LINE module, and asks the SIGNALING module to perform appropriate actions. The SIGNALING module interfaces with the SS#7 TRANSPORT NETWORK for the purpose of setting up a bearer channel between the calling and the called CENTRAL OFFICE SWITCHES. The TRUNK module transforms analog voice to a Time Division Multiplexed (TDM) format for transmission over PSTN trunks. The TRUNK module of the CENTRAL OFFICE SWITCH serving the called party converts the TDM trunk format back to analog for transmission over the local loop.

The Next Generation Networking Model

FIG. 2 illustrates the NGN approach. The NGN exhibits several similarities to the legacy PSTN. If one were to split apart the four modules that comprise the CENTRAL OFFICE SWITCH (see FIG. 1) into separate and distinct computing elements, the following components of a NGN network result:

MEDIA GATEWAY CONTROLLER
RESIDENTIAL GATEWAY
TRUNK GATEWAY
SIGNALING GATEWAY

To compare the functions of these elements to analogous functions in the CENTRAL OFFICE SWITCH, the MEDIA GATEWAY CONTROLLER (A.K.A. "softswitch," or "call agent) performs the functions of the CALL PROCESSING module, the RESIDENTIAL GATEWAY (A.K.A. "customer gateway") performs the functions of the LINE module and the TRUNK GATEWAY replaces the TRUNK module. Insofar as the RESIDENTIAL GATEWAY and TRUNK GATEWAY are both responsible for converting media provided in one type of network to the format required in another type of network, they are referred to generically as MEDIA GATEWAYS. With respect to support for network signaling functions, the SIGNALING GATEWAY in the