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US 5490285 A

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UK CL (Edition V) H4L
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(54) Abstract Title
Activity display for data channels over time

(57) An activity display for multiple data channels over a period of time for a communication link provides a quasi-three-dimensional presentation having time periods and data channels as orthogonal axes and shading within each time period/data channel rectangle representing ones density for the channel during that time period. One or more frames of the communication link corresponding to one time period may be captured, and then each frame processed in sequence one data channel at a time to build up a line of the display for the time period. Over multiple time periods the display may be built up line by line, with the oldest line being dropped as a new line is added when the maximum number of lines for the display is achieved. In this way an operator has a high level all-in-one glance at the operation of the communication link. The shading may be greyscale, colour coded, filling or patterns.
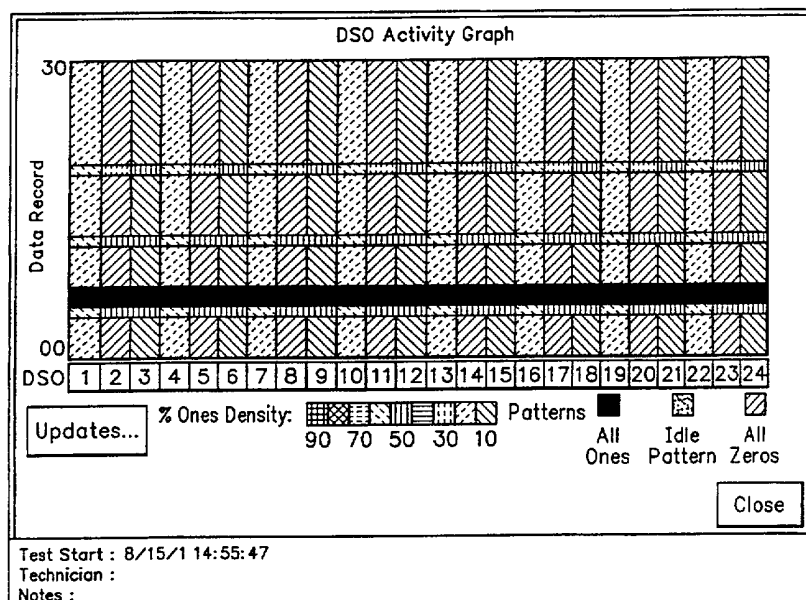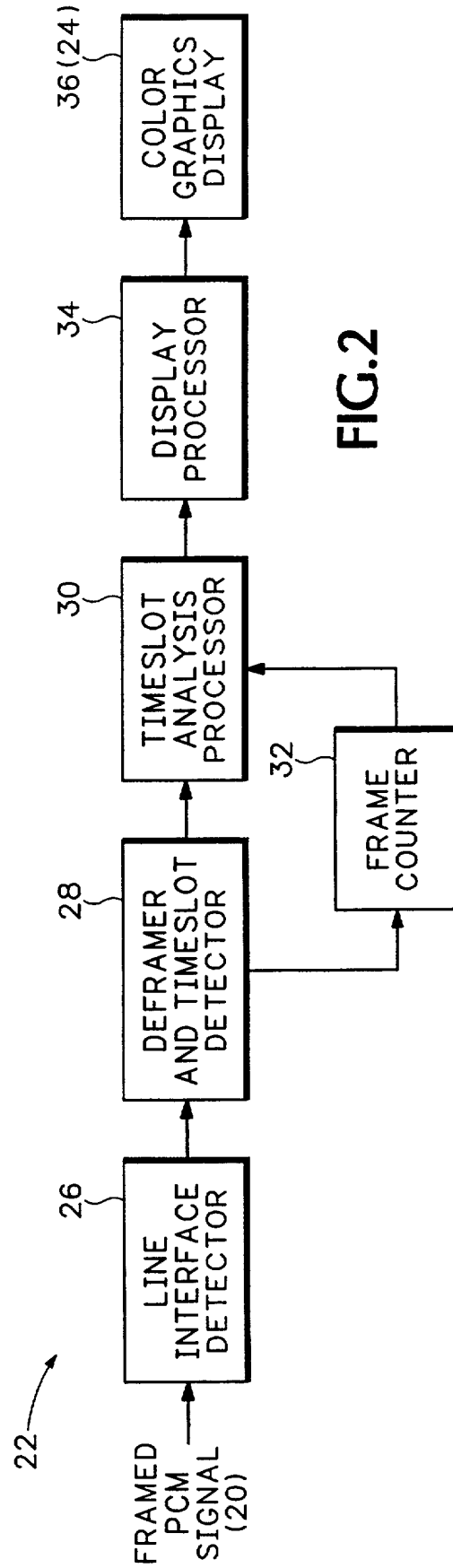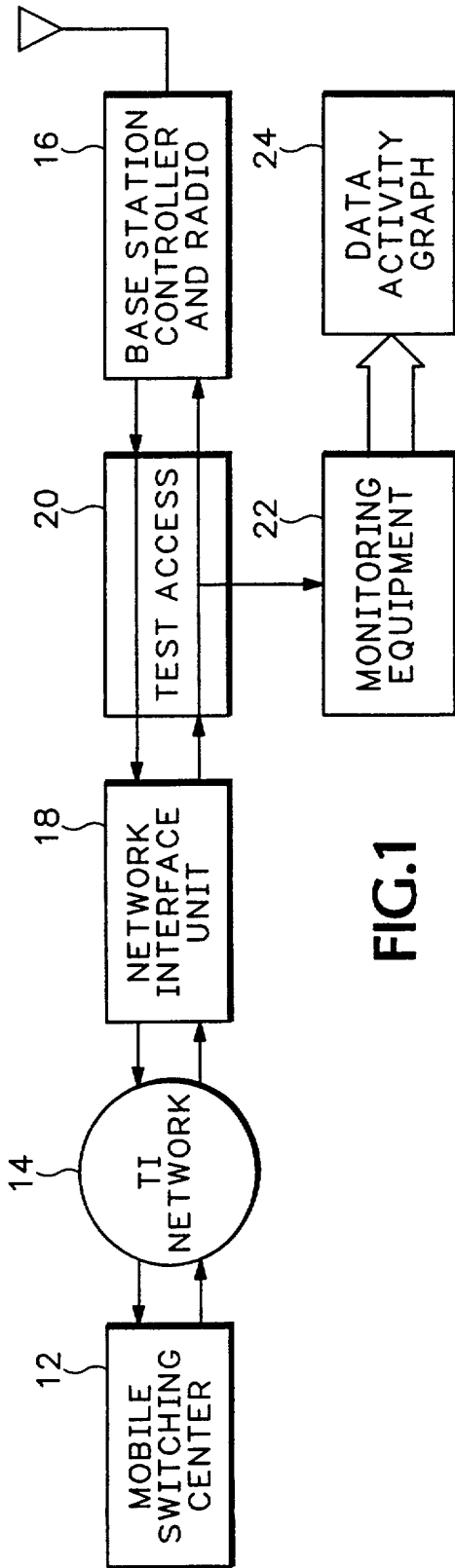

FIG.4

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FIG.1

MOBILE SWITCHING CENTER — 12

TI NETWORK — 14

NETWORK INTERFACE UNIT — 18

TEST ACCESS — 20

BASE STATION CONTROLLER AND RADIO — 16

MONITORING EQUIPMENT — 22

DATA ACTIVITY GRAPH — 24

FIG.2

FRAMED PCM SIGNAL (20)

22

LINE INTERFACE DETECTOR — 26

DEFRAMER AND TIMESLOT DETECTOR — 28

FRAME COUNTER — 32

TIMESLOT ANALYSIS PROCESSOR — 30

DISPLAY PROCESSOR — 34

COLOR GRAPHICS DISPLAY — 36(24)

(A)

FRAME_COUNTER=RV
TIMESLOT_COUNTER=0
ALL TPMI'S=NULL
ONES_DENSITY=0.0 —38

(B)

RECEIVE
ONE FRAME —40

(C)

EXTRACT TD MATCHING
TIMESLOT_COUNTER
FROM FRAME —42

RV= RESET VALUE

TRMI= "TIMESLOT PATTERN
MATCH INDICATOR"

TD= TIMESLOT DATA

PDP= PREVIOUS DATA PATTERN

44

TPMI FOR
THIS SLOT=NULL
? —YES→ CHECK TD
AGAINST KNOWN
PATTERNS —46

NO ↓

54

TPMI
FOR THIS SLOT
=ONES_DENSITY
? —NO→ CHECK TD
AGAINST PDP
ONLY —56

YES ↓

52

TPMI=
ONES_DENSITY ←NO—

48

MATCH
FOUND
?

58

RECALCULATE
ONES DENSITY FOR
THIS SLOT

50

YES ↓
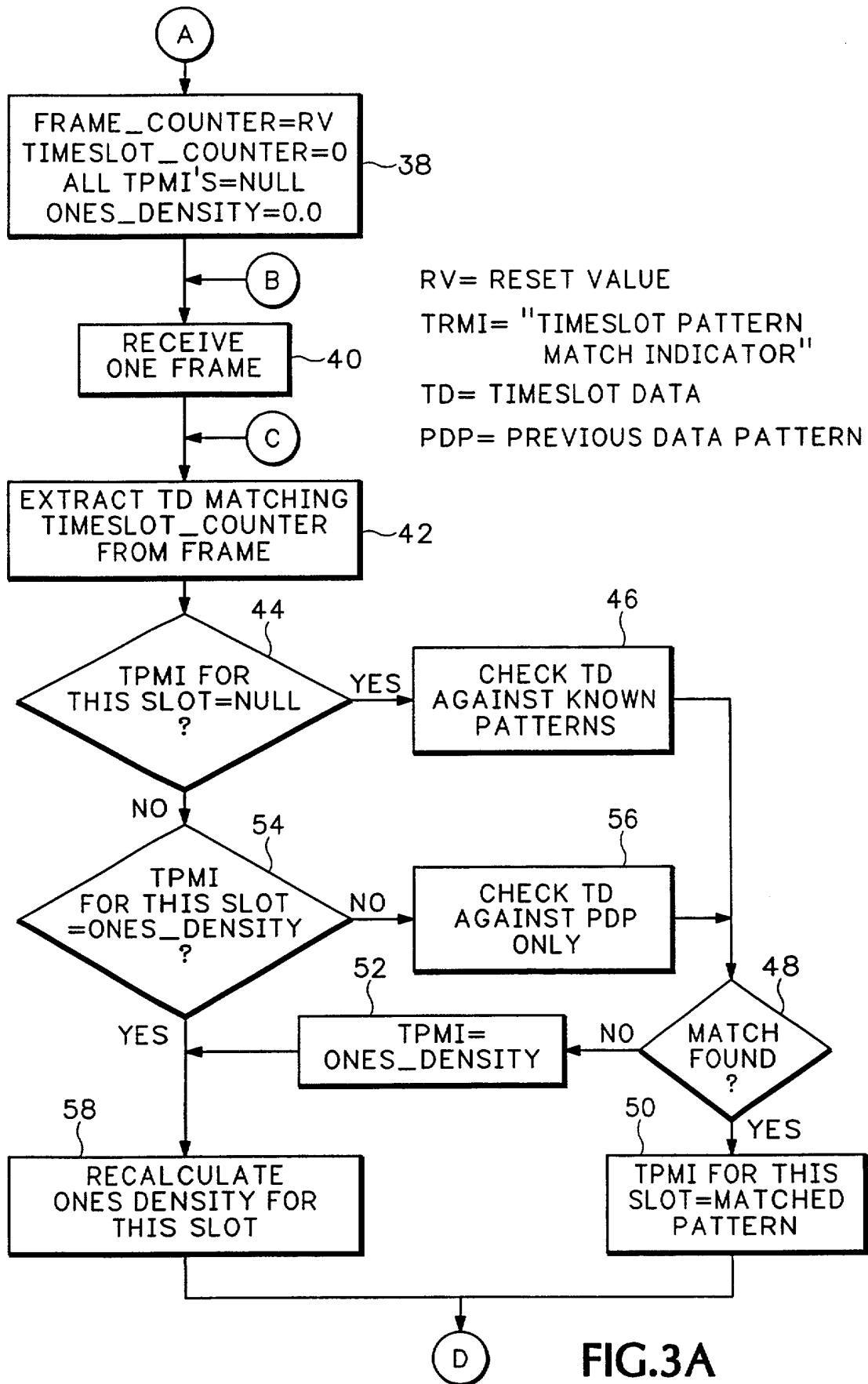
TPMI FOR THIS
SLOT=MATCHED
PATTERN

(D)

FIG.3A
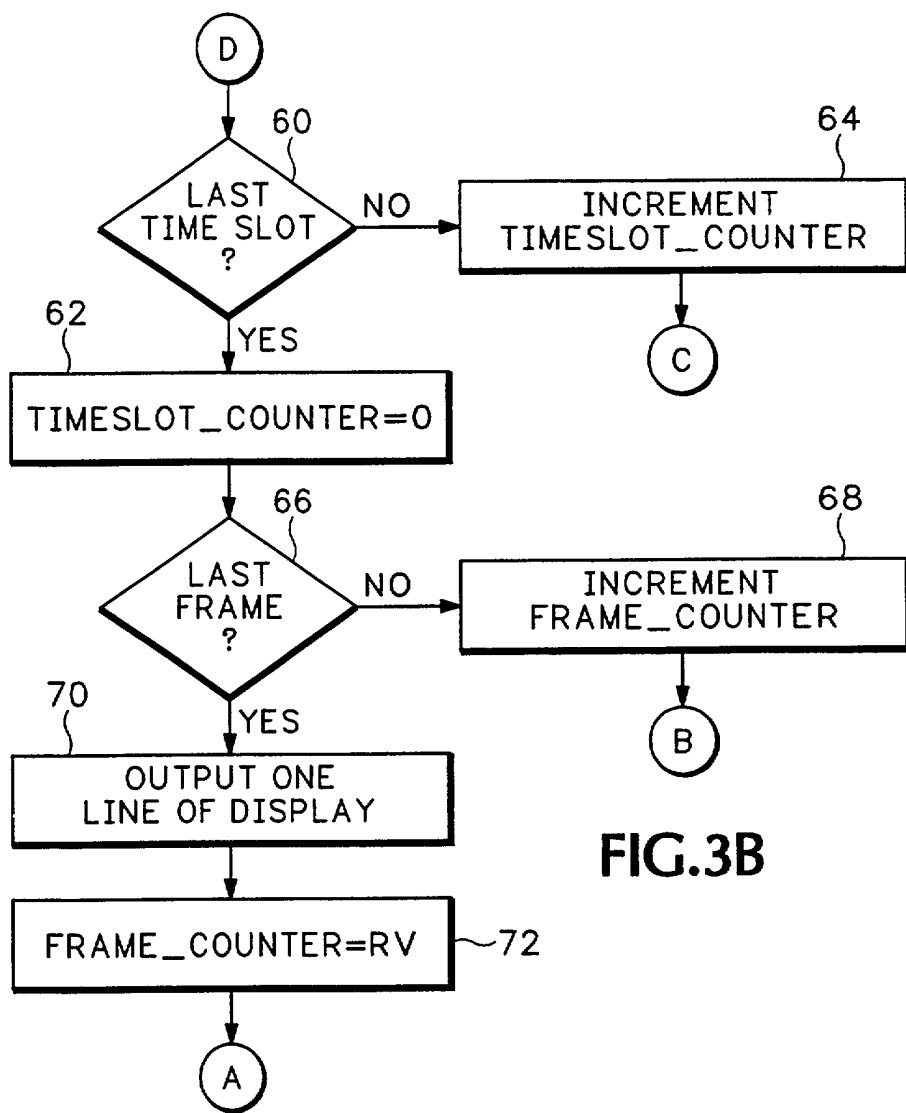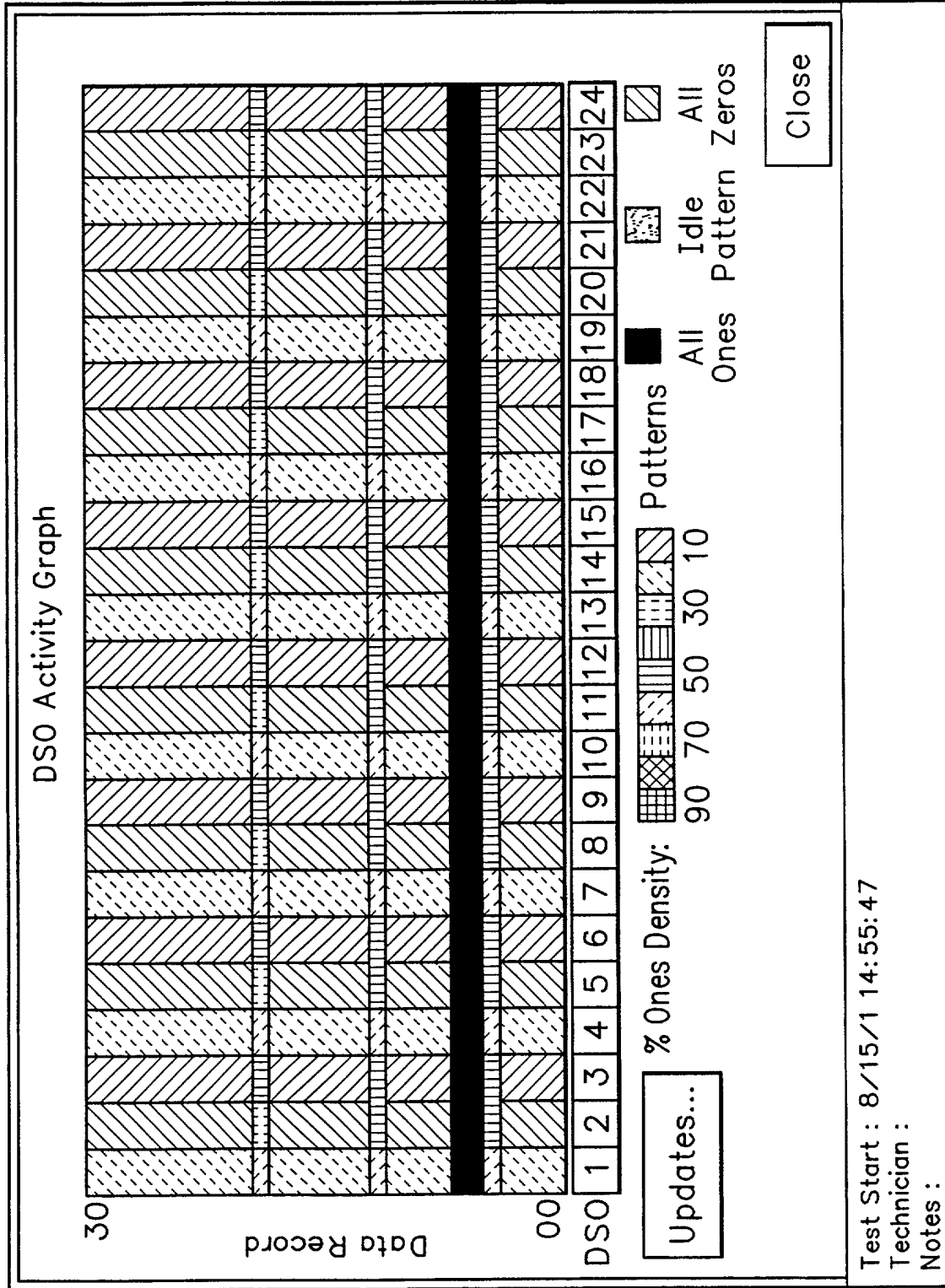
FIG.3B

FIG.4

ACTIVITY DISPLAY FOR MULTIPLE DATA CHANNELS OVER PERIOD OF TIME

BACKGROUND OF THE INVENTION

5   The present invention relates to wireless communication networks, and more particularly to a method of displaying activity on multiple data channels over a period of time for a communication link.

Wireless operators often need to verify correct communications between a wireless base station and a mobile switching center. Part of this verification involves

10   sensing patterns in actual data that are carried on a communication link. Since these patterns change over time and the data patterns differ between the various data channels being carried at the same time, a convenient method of displaying channel-versus-time-versus-detected pattern is of great use as a high level all-in-one-glance troubleshooting tool.

15   Control and content data flowing to and from the wireless base station typically is carried on telephone carrier lines which are multi-channel pulse-code modulation (PCM) based communication links, such as T1, E1, etc. Each communication link carries a number of time slots that define the channels, such as 24 for T1, 32 for E1, etc., each of which may contain a distinct data stream. Some of the data streams are voice

20   information from cellular telephones, while other data streams are signaling information that allows the mobile switching center and base station to communicate via one of various protocols. In some cases multiple time slots or channels are used to carry a single data stream, sometimes called a "packet pipe." Also each time slot may be routed through different paths within the telecommunication carrier network.

25

If the time slots are routed erroneously or the data carried in each time slot is incorrect, various problems result at the wireless base station. Certain well-known patterns in the data indicate specific problems which may be detected by viewing one or two time slots of data over a short period of time. However other patterns may require a correlation of several time slots over a more extensive period of time.

Presently the wireless operator may "view" this information one time slot or channel at a time by using a test set that displays the activity of a single time slot as a plurality of rapidly flashing lights and that also decodes the data as voice for play over a speaker. More advanced and more expensive equipment additionally may display the data over short periods of time as a series of mostly meaningless hexadecimal digits. Even more advanced equipment, such as protocol analyzers, may decode the protocol and give the user large amounts of detail about the data being carried on the communication link. In these cases the solution provides either too little or too much information of the wrong kind.

What is desired is a method of displaying activity on multiple data channels over a period of time sufficient to detect patterns in the data that are useful as a high level all-in-one-glance trouble shooting tool.

BRIEF SUMMARY OF THE INVENTION

Accordingly the present invention provides a method of displaying activity on multiple data channels over a period of time for a communication link by presenting a pseudo-three-dimensional graphic display having time periods along one axis, channel numbers or time slots along the orthogonal axis, and activity in the form of one's density as a fill shade, either grey scale or color, for each rectangle defined by each time period and time slot combination. Frames for each time period are captured from the communication link and processed data channel by data channel for each frame, and frame by frame for each time period. The results are then provided to the graphic display as one "line" of the display, and the next group of frames for the next time

period are captured and processed.

The objects, advantages and other novel features of the present invention are apparent from the following detailed description when read in conjunction with the

5   appended claims and attached drawing.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

Fig. 1 is a block diagram view of a typical wireless communication system having a monitoring system in place.

10   Fig. 2 is a block diagram view of a hardware architecture for displaying activity for multiple data channels over a period of time according to the present invention.

Fig. 3 is a flow chart view for displaying activity for multiple data channels over a period of time according to the present invention.

15   Fig. 4 is a plan view of a graphic display for showing activity for multiple data channels over a period of time according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to Fig. 1 a typical wireless communications system has a

20   mobile switching center 12 that communicates over a communication link 14, such as a T1, T3, E1 link or the like, with a base station 16. A network interface unit 18 couples the communication link 14 to the base station 16. In this particular implementation a test access port 20 is coupled between the network interface unit 18 and the base station, and a monitoring device 22 is coupled to the test access port to

25   monitor the communications from the mobile switching center 12 to the base station 16. The monitoring device 22 processes the data captured via the test access port 20 and provides a data activity graph 24.

A typical monitoring device 22 is shown in Fig. 2 where a communication signal, such as a framed PCM signal, from the test access port 20 is captured by a

"line" interface detector **26**. The captured signal has one or more frames which are then processed by a deframer and timeslot detector **28**. Each frame is processed individually by a timeslot analysis processor **30**. Each detected frame is also used to increment/decrement a frame counter **32** which provides a time period input to the timeslot analysis processor **30**. Output from the timeslot analysis processor **30** for each time period or line on a display, which includes one or more frames, is a one's density value for each time slot or data channel within the time period for processing by a display processor **34**. The frame counter **32** may be set with a specified value that determines the time period, and each detected frame decrements the count until zero is reached, at which point the timeslot analysis processor **30** provides the output to the display processor **34**. The frame counter **32** recirculates to the preset value for the next time period. Alternatively the frame counter output may be compared to a preset frame value, with the frame counter **32** being incremented for each frame and reset to zero when the preset frame value is attained, indicating the end of the time period. The output from the display processor **34** is the data activity graph **24** which appears on a graphic display device **36**, such as a cathode ray tube (CRT), liquid crystal display (LCD) or the like. The timeslot analysis processor **30** may also perform other analyses of the PCM signal, such as protocol identification and analysis. Each time slot may have a different protocol, and in the case of packet pipes the protocol may extend over more than one time slot. In this case the timeslot analysis processor **30** does a correlation of known protocol headers for each time slot, or group of time slots for packet pipes, to identify the protocol of the data within that time slot or packet pipe. Once the protocol is known, further analysis may be made on the data within that time slot or packet pipe, such as determining what commands or controls are being exerted as well as determining whether the protocol is performing a proper operation.

One type of analysis of the captured data is illustrated in Figs. 3A and 3B. For each time period the method is initiated at step **38**. One frame of data from the

deframer and timeslot detector **28** is provided to the timeslot analysis processor **30** in step **40**. The timeslot analysis processor **30** then in step **42** extracts data from the time slot within the frame corresponding to a time slot counter. Each time slot is assigned a Timeslot Pattern Match Indicator (TPMI) which is tested at step **44**. If the TPMI is in its initial state == NULL, then the timeslot data is checked against known patterns in step **46**. Such patterns may include all zeros, all ones, a channel idle pattern (determined by the protocol), etc. If a pattern match is found at step **48**, the TPMI for the time slot is set to identify the matched pattern at step **50**, otherwise it is set to indicate Ones_Density as the pattern match. If at step **44** the TPMI is not NULL, then it is tested at step **54** to see if it's set to Ones_Density. If the TPMI at step **54** is not set to Ones_Density, it is checked against a previous data pattern at step **56** and, if there is a match in step **48**, TPMI is set to the matched pattern value. Otherwise from step **54** the ones density for the time slot is recalculated with prior frames of data from the time period at step **58**. If the time slot data is from the last time slot of the current frame being processed as determined at step **60**, the timeslot counter is reset to zero in step **62**. Otherwise the timeslot counter is incremented at step **64** and the new time slot data from the current frame is processed starting at step **42**. If it is the last time slot, after the timeslot counter is reset to zero a test is made to determine if it is the last frame for the time period at step **66**. If not, then the frame counter **32** is incremented/decremented at step **68** and the next frame of the captured data is processed at step **40**. Otherwise processing for the time period is complete and one "line" of the data activity graph **24** is output at step **70** for display on the graphics display device **36** and the frame counter **32** is reset at step **72**. Processing then returns to the initialization step **38** to process newly captured data for the next time period.

The resulting data activity graph 24 is shown in Fig. 4 where the vertical axis represents data records, lines or time periods and the horizontal axis represents time slots or data channels. In this example there are 31 data records and 24 channels. The graph 24 may be shaded in grey scale levels or, preferably, in a color code where, for example, black represents an all one's pattern, grey represents an idle pattern, red represents an all zero's pattern, and percentage of one's density is represented by a range of colors not including red, such as yellow through magenta. Therefore reading the data for channel 1 vertically from the top the color scheme indicates that channel 1 had a one's density of 20 percent, then the one's density changed briefly to 60% when errors were introduce, then back to 20%, then 60% when errors were introduced again, then black when the channel was turned off briefly, etc. The particular channel selected may be indicated in some distinctive manner, such as changing the background color for the channel number, and for packet pipes all the corresponding channels that make up the packet pipe also may be indicated as selected when one channel of the packet pipe is selected.

Thus the present invention provides a data activity graph for a communication link that is quasi-three-dimensional display by plotting time period versus data channel within the communication link as orthogonal axes and indicating one's density for each such defined rectangle by a shade, either grey scale or color.

CLAIMS:

1. An activity display for multiple data channels of a communication link over a period of time comprising a quasi-three-dimensional graphics display having time periods as a first axis, data channels as a second axis orthogonal to the first axis, and a shade within each rectangle defined by the time periods and data channels corresponding to a ones density for the data in the respective data channels during the respective time periods.

2. The activity display as recited in claim 1 wherein the shade is selected from a range of grey scale values.

3. The activity display as recited in claim 1 wherein the shade is selected from a plurality of color values.

4. A method of providing an activity display for multiple data channels of a communication link over a period of time comprising the steps of:

capturing a line of data from the communication link, the line of data having one or more frames of data corresponding to a predetermined time period, each frame of data having data for the multiple data channels;

processing each frame of the line of data in sequence to determine a ones density value for the data of each data channel during the predetermined time period; and

displaying the line of data as shades corresponding to the ones density values.

5. The method as recited in claim 4 further comprising the step of repeating the capturing, processing and displaying steps for a plurality of lines of data to produce a quasi-three-dimensional graphic display having the predetermined time periods as one axis, the data channels as an orthogonal axis, and the shades as a graphic fill for rectangles produced by the orthogonal axes.

6. The method as recited in claim 5 wherein the shades comprise a plurality of grey scale values corresponding to different specified patterns and percentages of ones density.

7. The method as recited in claim 5 wherein the shades comprise a plurality of color values corresponding to different specified patterns and percentages of ones density.

8. The method as recited in claim 4 wherein the processing step comprises the steps of:

for each frame in sequence of the line of data extracting data for the data channel of a current frame corresponding to a timeslot counter value;

matching the extracted data against known data patterns;

setting a pattern match indicator for the data channel according to whether a match is found with the known data patterns;

if no match is found recalculating the ones density based on the current frame and prior frames of the captured line of data; and

repeating the extracting, checking, setting and recalculating steps for each data channel of the current frame.

9. The method as recited in claim 8 further comprising the step of outputting one line of display data after all the frames have been processed for the line of data, the line of display data including the pattern match indicator and the recalculated ones density value for each data channel.

10. An activity display substantially as herein described with reference to and as shown in the accompanying drawings.

11. A method substantially as herein described with reference to and as shown in the accompanying drawings.

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A	-	US 5490285 (AHLENIUS ET AL) See abstract and figure 3.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^V:

H4L

Worldwide search of patent documents classified in the following areas of the IPC^7:

H04Q

The following online and other databases have been used in the preparation of this search report:

WPI, EPODOC, JAPIO, INSPEC