Patents:
List with Isaac Shpantzer as Inventor, reverse chronological order of filing date, sorted by year:
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2011

Quadrature modulator with feedback control and optical communications system using the same
US 20120014470 A1

ABSTRACT
The method and system are disclosed for automatic feedback control of integrated optical quadrature modulator for generation of optical quaternary phase-shift keyed signal in coherent optical communications. The method comprises the steps of detecting at least a part of an output optical signal from the QPSK modulator, extracting of a particular portion of the output signal in frequency domain, and processing the signal in frequency domain to optimize the transmission of an optical link. The system and method of optical communications in fiber or free space are disclosed that implement the quadrature data modulator with automatic feedback control.

Secure orthogonal frequency multiplexed optical communications
US 8532498 B2

ABSTRACT
The invention provides a system and method for secure communication that involve encoding and transmitting an optical orthogonal frequency division multiplexed (OFDM) signal. Each subcarrier of an optical carrier in OFDM transmission is modulated with data individually, and a variety of data format are used, such as QPSK, OOK, QAM, etc. The data format of each subcarrier may change in time according to a predetermined pattern. An optical receiver uncovers the data transmitted via an optical link. It is based on a coherent optical receiver and a digital signal processing (DSP) unit. A key to the data mapping and change is transmitted via the same optical link or by a separate channel. In one embodiment, the key is transmitted using quantum encryption technique. Besides subcarrier modulation encoding, the system may provide additional layers of security: optical carrier frequency hopping and polarization scrambling.

2010

Parallel optical receiver for optical systems
US 20100310256 A1

ABSTRACT
The present invention discloses a receiver for optical system, which provides improved performance due to implementation of multiple parallel analog-to-digital converters. Such configuration allows reducing the data speed processing thus improving bit-error-rate. Each channel of the WDM communications system consists of a set of orthogonal spectral bands. These bands are modulated via orthogonal frequency division multiplexing (OFDM)
A technique using M-PSK modulation format. At the receiver side, the incoming optical beam is split into a set of parallel branches. Each branch is mixed with a local oscillator beam having a spectrum within one sub-band of the WDM channel. In the preferred embodiment these beams are mixed in 90-degrees optical hybrid, which is followed by a set of balanced photodetectors. The baseband of each sub-band signal is converted into a digital signal using ADC. This allows the implementation of a series of lower-speed ADCs working in parallel instead of one high-speed ADC for the data recovery from the incoming optical signal.

Optical orthogonal frequency division multiplexed communications with nonlinearity compensation

ABSTRACT

The present invention discloses a transmitter and receiver for optical communications system, which provide compensation of the optical link nonlinearity. M-PSK modulating is used for data embedding in an optical signal in each WDM channel using orthogonal frequency division multiplexing (OFDM) technique. At the receiver side electrical output signals from a coherent optical receiver are processed digitally with the link nonlinearity compensation. It is followed by the signal conversion into frequency domain and information recovery from each subcarrier of the OFDM signal. At the transmitter side an OFDM encoder provides a correction of I and Q components of a M-PSK modulator driving signal to compensate the link nonlinearity prior to sending the optical signal to the receiver.

Optical sensor for detecting and localizing events

ABSTRACT

A system and method for a structure monitoring and locating a disturbance event is disclosed. The system includes a compact transceiver chip sending optical signals in three optical fibers that encompass the monitored structure appropriately. The system contains a sequence of loops, wherein the first and the second fiber forming the loop clockwise, while the third fiber is winded along the same loop counterclockwise. A set of two detectors registers the returning signals, and a time delay between those signals is calculated, which is indicative of the disturbance event location. The event location is determined with different sensitivity in different parts of the monitored structure depending on the density of fibers in these parts.

Detection of high Z materials using reference database

ABSTRACT

A method and system for high Z substance revealing using muon detection technique is presented. Natural muon coordinate and incidence angle are measured above and below the interrogated volume. The muon deviations after passing through the interrogated volume are compared with the reference deviations obtained for the same volume in absence of high Z material. A correlation between the actual data and reference data is calculated using
Kolmogorov-Smirnov test, though other approaches may apply. The correlation is used for the decision making on the presence of a nuclear substance inside the volume.

**Inspection system and method**

**US 8019556 B2**

**ABSTRACT**

A method and system for nuclear substance revealing using muon detection technique is presented. In some aspects, naturally occurred muons are selected from the flow of charged particles. Muon coordinate and incidence angle measured above and below the interrogated volume can be used for the decision making on the presence of nuclear substance inside the volume. The system is adapted for performing measurements on moving objects such as moving trucks. A combination of the nuclear substance detection system with an explosive sensing system is presented.

**Optical orthogonal frequency division multiplexed communications with nonlinearity compensation**

**US 7693428 B2**

**ABSTRACT**

The present invention discloses a transmitter and receiver for optical communications system, which provide compensation of the optical link nonlinearity. M-PSK modulating is used for data embedding in an optical signal in each WDM channel using orthogonal frequency division multiplexing (OFDM) technique. At the receiver side electrical output signals from a coherent optical receiver are processed digitally with the link nonlinearity compensation. It is followed by the signal conversion into frequency domain and information recovery from each subcarrier of the OFDM signal. At the transmitter side an OFDM encoder provides a correction of I and Q components of a M-PSK modulator driving signal to compensate the link nonlinearity prior to sending the optical signal to the receiver.

**Single chip two-polarization quadrature synthesizer, analyser and optical communications system using the same**

**US 8285153 B2**

**ABSTRACT**

An optical beam synthesizer formed on a single chip is provided. It allows M-PSK modulation for both beam polarizations. The synthesizer comprises an optical pulse shaper and two M-PSK modulators for each polarization. A single-chip-integrated analyzer is provided to receive a modulated data. Analyzer comprises a pulse shaper operating as an optical sampler and a pair of 90-degrees optical hybrids for each polarization. Each optical hybrids mix incoming portions of the modulated beams with portions of the local oscillator beams. Both the synthesizer and the analyzer include a set of mirrors located on the back and front surfaces of the chips to create compact designs. The output beams from the analyzer are detected by a set of balanced photodiodes, and the data is recovered. It is
another object of the invention to provide a communication system for data transmission having the synthesizer and the analyzer.

**Space diversity receiver for optical communications**  
**US 7949262 B2**  
**ABSTRACT**

An optical beam combiner is provided, which allows efficient collection of light for various applications: non-line of sight and free-space optical communications, remote sensing, optical imaging and others. A multitude of transverse scattered optical beam portions is captured by the multi-aperture array positioned perpendicular to the beam projection direction. These beam portions are combined first into a single optical waveguide with modulating the beam portions phase and coupling ratio of directional couplers in the optical beam combiner tuned to maximize the final output power. A portion of the output beam is used for the power detection and forming a feedback signal for the phases and coupling ratios adjustment. The data is recovered from the received optical beam using coherent detection.

**Chemical sensing system and method**  
**US 8009294 B2**  
**ABSTRACT**

A photo-thermal, interferometric spectroscopy system is disclosed that provides information about a chemical, such as explosives and the like, at a remote location. It may be used for solid residue detection on a surface. The system includes a novel light detector system with a matrix of optical elements focusing portions of a received light beam on input waveguides of an optical combiner. The combiner adjusts the phases of the received beam portions and combines them together to maximize the intensity of an output beam. The output beam is detected by a detector, and information about at least one of, absorption spectrum and concentration of the chemical is recovered. In the preferred embodiment the detector is a coherent detector based on 90-degrees optical hybrid.

**2008**

**Optical receiver and a free-space optical communications using the same**  
**US 7974543 B2**  
**ABSTRACT**

A device for phase distortion compensation across an optical beam is provided. The device is a part of an optical receiver, which can be used in free space optical communications, remote sensing, optical imaging and others. $2^M$ inputs of the combiner interfere with each other via a system of tunable coupled waveguides. The phases in interleaved waveguides of the combiner are adjusted to maximize the resulting output signal. The combiner may be
used for coherent communication in combination with a balanced 90° hybrid. Integrated solutions for the proposed device are provided.

System and method for high Z material detection
US 7897925 B2
ABSTRACT
A method and system for high Z material revealing using muon detection technique is presented. The system measures muons' coordinates, velocities, incidence angles and leaving angles. Two series of detectors: one above and one below the interrogated volume are used. A muon trajectory deviation from an expected trajectory is used for the decision making on the presence of high Z material inside the volume. The muon velocity is measured using either a ring Cerenkov counter, a transition radiation detector or/and a threshold Cerenkov counter. The expected trajectory is calculated basing on known particle velocity.

Optical frequency division multiplexed communications over the horizon
US 20080310847 A1
ABSTRACT
A non-line of sight (NLOS) communications system and method are provided that implement orthogonal frequency, division multiplexing. A data generator produces a digital data stream, which is converted into M parallel frequency sub-carrier digital data streams (where M is an integer), each sub-carrier is encoded with data and an Inverse Fast Fourier Transform operation is applied, and an output signal is converted to an analog signal, which is imposed onto an optical beam generated by a light source. The beam is transmitted skywards at an elevation angle above the horizon in at least one direction. The beam is scattered due to Mie and Raleigh effects, forming a scattered waveform. At least a part of the scattered waveform is received by a receiver outputting an electrical signal, which enters a DSP unit. The DSP unit digitizes the electrical signal, performs Fourier transformation and recovers data from M sub-carrier signals.

Secure optical communications system and method with coherent detection
US 20100028024 A1
ABSTRACT
The invention provides a system and method for secure communication that involves encoding and transmitting an optical communications signal that is encoded based on a multi-dimensional encoding technique. This technique may include at least one or more of encoding a phase, a polarization, and a frequency of the signal. Light encoding is independent from its modulation with data. The data is modulated using any format; in the preferred embodiment the QPSK format is implemented. The encoded and modulated light is transmitted through free space or via a fiber optic network to a receiver, where the information is decoded. A coherent detection based on 90-degrees or 120-
degrees optical hybrid is used to decode and recover the data from the received signal. Because the encoding of the transmitted light varies according to a specific pattern or sequence, one without knowledge of the transmission encoding sequence is prevented from decoding the transmitted information.

2007

Non-line of sight optical communications
WO 2008147455 A1
ABSTRACT
A non-line of sight (NLOS) communications system and method are provided. An ensemble of photodetectors is used to collect the light, scattered in the sky being illuminated by initial pulsed laser beam carrying information. Each detector collects scattered light from one area in free space along the initial light propagation line. The same bit of information is detected multiple times on multiple detectors during the pulse transmission along its propagation path. Signals received by multiple detectors are synchronized and processed in a digital signal processing unit. Improved system sensitivity and reliability is achieved by multiple registration of the same bit of information. Special selection of the areas in free space ensures detection of a single bit of information during the time equal to a bit period.

Coherent optical detector and coherent communication system and method
US 7801395 B2
ABSTRACT
An optical device is provided with first and second inputs. A first coupler coupled is coupled to the first input and produces at least a first and second output. A second coupler is coupled to the second input and produces at least a first and second output. A third coupler is coupled to the first output of the first coupler and to the first output of the second coupler. A fourth coupler is coupled to the second output of the first coupler and to the second output of the second coupler. First and second crossing waveguides are provided with an angle selected to minimize crosstalk and losses between the first and second cross waveguides. The first crossing waveguide connects one of the first or second outputs from the first coupler with an input of the fourth coupler. The second crossing waveguide connects one of the first or second outputs from the second coupler with an input of the third coupler. A first phase shifter is coupled to the first and second waveguides. The first and second waveguides connect one of the outputs of the first or second coupler and one of the inputs of the third or fourth couplers. The first, second, third and fourth couplers, the two crossing waveguides and the phase shifter are each formed as part of a single planar chip made of an electro-optical material.
**Quadrature modulator with feedback control and optical communications system using the same**

**US 8050351 B2**

**ABSTRACT**

The method and system are disclosed for automatic feedback control of integrated optical quadrature modulator for generation of optical quaternary phase-shift-keyed signal in coherent optical communications. The method comprises the steps of detecting at least a part of an output optical signal from the QPSK modulator, extracting of a particular portion of the output signal in frequency domain, and processing the signal in frequency domain to optimize the transmission of an optical link. The system and method of optical communications in fiber or free space are disclosed that implement the quadrature data modulator with automatic feedback control.

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**High sensitivity coherent photothermal interferometric system and method for chemical detection**

**US 7502118 B2**

**ABSTRACT**

A photo-thermal interferometric spectroscopy system is disclosed that provides information about a chemical at a remote location. A first light source assembly is included that emits a first beam. The first beam has one or more wavelengths that interact with the chemical and change a refractive index of the chemical. A second laser produces a second beam. The second beam interacts with the chemical resulting in a third beam with a phase change that corresponds with the change of the refractive index of the chemical. A detector system is positioned remote from the chemical to receive at least a portion of the third beam. An adaptive optics system at least partially compensates the light beam degradation caused by atmospheric turbulence. A focusing system is used to bring together the light passed through the chemical; the focusing system includes a multimode fiber for the light collection. The detector system provides information on a phase change in the third beam relative to the second beam that is indicative of at least one of, absorption spectrum and concentration of the chemical.

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**Integrated coherent optical detector**

**US 7483600 B2**

**ABSTRACT**

The present invention provides an integrated device and a method of its fabrication and use. Two parts of the device each having an electronic circuit are aligned adjacent to each other with an accuracy of at least 1 micron. An alignment system includes two parts: a first part integrated with the first electronic circuit of the integrated device on the first substrate and a second part integrated with the second electronic circuit of the integrated device on the second substrate. The second part of alignment system includes at least one photodiode. The maximal value of the photodiode current indicates the best alignment of two parts of the integrated device. In one embodiment the integrated device is a coherent optical detector for high speed optical communications and chemical sensing. In another embodiment the integrated optical device is a coherent optical detector operating in two polarization states of light.
Method and system for nuclear substance revealing using muon detection
US 7652254 B2

ABSTRACT

A method and system for nuclear substance revealing using muon detection technique is presented. In some aspects, naturally occurred muons are selected from the flow of charged particles. Muon coordinate and incidence angle measured above and below the interrogated volume can be used for the decision making on the presence of nuclear substance inside the volume. The system is adapted for performing measurements on moving objects such as moving trucks. A combination of the nuclear substance detection system with an explosive sensing system is presented.

2006

Method and apparatus for pulse generation and adaptive pulse generation for optical communications
US 7391969 B2

ABSTRACT

One embodiment of the invention relates to producing optical pulses for use on a transmission link. A light source is configured to produce an optical signal. A pulse generator is coupled to the light source. The pulse generator is configured to receive, for a first channel, the optical signal and a clock signal. The pulse generator is also configured to modify the optical signal based on the clock signal to produce an optical pulse having a predetermined pulse shape. The clock signal is associated with the predetermined pulse shape. The predetermined pulse shape being based on a transmission characteristic of the transmission link.

System and method for chemical sensing using trace gas detection
US 7426035 B2

ABSTRACT

A system and method is proposed for chemicals detection such as explosives and others, which are based on sensing of trace gases associated with the chemical. This sensing includes detection of spectrum and relative concentration of the trace gases followed by the chemical identification based on these data. The sensing is based on photothermal interferometry method modified by implementation of coherent optical detection. This modification essentially improves the device performance by increasing its sensitivity and selectivity. Improved characteristics of the device allow remote sensing of the interrogated chemicals at a distance up to 1000 meters, which is crucial for explosives detection. The coherent optical detection is performed by a coherent receiver based on 90-degrees optical hybrid.
2005
Coherent photothermal interferometric spectroscopy system and method for chemical sensing
WO 2007001379 A3
ABSTRACT
A photo-thermal, interferometric spectroscopy system is disclosed that provides information about a chemical at a remote location. A first light source assembly is included that emits a first beam. The first beam has one or more wavelengths that interact with the chemical and change a refractive index of the chemical. A second laser produces a second beam. The second beam interacts with the chemical resulting in a third beam with a phase change that corresponds with the change of the refractive index of the chemical. A detector system is positioned remote from the chemical to receive at least a portion of the third beam. The detector system provides information on a phase change in the third beam relative to the second beam that is indicative of at least one of, absorption spectrum and concentration of the chemical.

Laser vibrometry with coherent detection
US 7242481 B2
ABSTRACT
An optical system provides information about tangential vibration components of a surface at remote location. The optical system includes a light source assembly that emits first and second beams, each having one or more wavelengths and one or two polarizations. The first and second beams are directed to the interrogated surface. A detector system is positioned to detect a third beam formed by at least a portion of the first and second beams being reflected from the interrogated surface. The first, second and third beams having incident and reflection angles relative to the interrogated surface that do not lay in a same plane. The detector system positioned remotely from the interrogated surface, and providing information on a phase change in the third beam relative to the first and second beam. The phase change is indicative of at least one surface vibration vector component of the interrogated surface. The detector system is a 90 degree optical hybrid balanced detector with four photodiodes.

2004
Coherent optical detector and coherent communication system and method
WO 2005029140 A3
ABSTRACT
An optical device is provided with first and second inputs. A first coupler coupled is coupled to the first input and produces at least a first and second output. A second coupler is coupled to the second input and produces at least a first and second output. A third coupler is coupled to the first output of the first coupler and to the first output of the second coupler. A fourth coupler is coupled to the second output of the first coupler and to the second output of the second coupler. First and second crossing waveguides are provided with an angle selected to minimize
crosstalk and losses between the first and second cross waveguides. The first crossing waveguid connects one of the first or second outputs from the first coupler with an input of the fourth coupler.

2003

Electro-optical integrated transmitter chip for arbitrary quadrature modulation of optical signals
WO 2004005972 A2

ABSTRACT

An optical device includes, a first Mach-Zehnder modulator (105, 106) that produces a first output and a second Mach-Zehnder modulator (205, 206) which produces a second output. A splitter (212) couples the first and second Mach-Zehnder modulators. A combiner (213) combines the first and second outputs. A phase shifter (107, 207) is coupled to the first and second Mach-Zehnder modulators. The first Mach-Zehnder modulator, second Mach-Zehnder modulator, splitter, combiner and the phase shifter are each formed as part of a single chip made of electro-optical material. Such two similar optical device integrated together with polarization combiner provide a two-polarization performance.

System and method for multi-dimensional encoding
US 7418209 B2

ABSTRACT

The invention provides, according to its various embodiments, a method for secure communication that involves encoding and transmitting an optical communications signal that is encoded based on a multi-dimensional encoding technique. The multi-dimensional encoding technique includes multiple security layers and varies multiple physical characteristics of a communications signal. The multi-dimensional encoding technique may include at least one or more of encoding a phase of an optical communications signal, encoding a polarization of an optical communications signal, and encoding a frequency of an optical communications signal, or any combination thereof. According to embodiments of the invention, the encoding and/or any decoding of the optical communications signal may be carried out using one or more of an optical phase shift coding, a polarization multiplexing, and a multi-wavelength control. Multi-dimensional encoding and decoding keys are provided.

2002

Method and system for mitigating nonlinear transmission impairments in fiber-optic communications systems
US 7224906 B2

ABSTRACT

The present invention relates to a method for transmitting data. An optical pulse stream comprising a plurality of return-to-zero optical pulses is prepared by modulating a phase of light output by an optical source to thereby
encode data from a data source. The light of the optical pulse stream has a wavelength. The optical pulse stream is transmitted along an optical fiber of an optical network. Optical pulse streams of the invention enhance transmission performance at least in part by reducing noise at the receiver caused by fiber non-linearities.

Method and system for acoustically tuning a light source
US 6671425 B1
ABSTRACT
The present invention relates to an integrated light source having first and second optical waveguides defining a first optical coupling region for coupling light therebetween. At least one of the optical waveguides includes a gain medium configured to emit light upon irradiation. The light source also includes a first acoustic wave source to subject the first optical coupling region to acoustic waves having a longitudinal frequency $\omega_{AC1}$, whereby a frequency of light propagating along one of the first and second waveguides differs from a frequency of light propagating along the other waveguide by an amount $\omega_{AC1}$.

Light source for generating an output signal having spaced apart frequencies
US 20020196509 A1
ABSTRACT
A multiple wavelength light source generates an output signal having a comb of accurately spaced apart frequencies with variable free spectral range in the C-band of optical fiber communication. The light source employs an electro-optical modulator (EOM) driven by a signal generator which modulates with EOM with multiple modulation frequencies to widen the output spectrum of signal. The EOM has a crystal provided with a waveguide. The waveguide may be doped with a rare-earth metal to impart gain properties to equalize the intensities of the comb. In one preferred embodiment, Er, Yt or other doping elements provide the gain property to waveguides. The crystal is also provided with periodically poled structure, and this may be engineered so as to form domains of unequal widths to improve the efficiency of modulation. The output signal from the light source may be split and presented to a bank of filters to create a multiple signals, each signal having one of the spaced apart frequencies. The output signals may be used as channels to be modulated by data and then combined in dense wavelength division multiplexing system, or may be used as a soliton source in time-division multiplexed communication systems.

2001
System and method for code division multiplexed optical communication
WO 2002027994 A1
ABSTRACT
A system for optical communication (2a) forms a family of orthogonal optical codes modulated by a data stream. The orthogonal codes are formed by creating a stream of evenly spaced-apart pulses using a pulse spreader circuit and modulating the pulses in amplitude and/or phase to form a family of orthogonal optical code words, each representing a symbol. A spreader calibration circuit is used to ensure accurate timing and modulation. Each code word is further modulated by a predetermined number of data bits. The data modulation scheme splits a code word into H and V components, and further processes the components prior to modulation with data, followed by recombining with a polarization beam combiner. The data-modulated code word is then sent, along with others to receiver. The received signal is detected and demodulated with the help of a symbol synchronization unit which establishes the beginning and end of the code words. A polarization mode distortion compensator (275) at the receiver cooperates with a state of polarization compensator at the transmitter to mitigate polarization distortion in the fiber.

1995

Data communication system with time synchronization
EP 0702464 A1
ABSTRACT
A data communication system is provided having time synchronization over RF or other high latency infrastructure, between a first location having a first clock and a first data transmission device and a second location having a second clock and a second data transmission device. The system time-synchronizes the clocks over infrastructures by determining a first time corresponding to the first clock time, determining a second time corresponding to the second clock time, transmitting data concerning the first time from the first data transmission device to the second data transmission device, comparing the second time with the first time, calculating the difference between the second time and the first time, and then adjusting one of the clocks to synchronize with the other of the clocks.

Data communication system with adaptive concatenation
EP 0705013 A1
ABSTRACT
A data transmission system is provided for transmitting digital data messages to a plurality of destinations. When a digital data message is received, its destination is determined. If the destination of the received message is the same as the destination of a previously received message, the message is concatenated with the previously received message into a destination packet. If the destination of the received message is not the same as the destination of a previously received message, a new destination packet is provided. The destination packets are queued and are transmitted periodically via radio.

1994
Data communication system using spectral overlay
US 5548805 A

ABSTRACT

A data communication system is provided for use with a cellular system containing an array of cells and a cellular transmitter/receiver located within each cell of the array. Each cellular transmitter/receiver is adapted for transmitting and receiving voice and/or data communication over predetermined channelized frequencies associated with the particular cell in which the cellular transmitter/receiver is located. In accordance with the invention a base data transmission station is located in each cell and is adapted for transmitting a single data stream across a plurality of channels, each of which channels is adapted to carry a single stream of information. Each base data transmitting station does not transmit on the predetermined channels that are assigned to the particular cell in which the base data transmitting station is located (i.e., those channels are "notched"). In one embodiment used channels that are carrying streams of information in adjacent cells are detected and the base data transmission station does not transmit over the frequencies of the used channels (i.e., the used channels are "notched"). In this manner, the single data stream transmitted by the base data transmitting station is transmitted over all of the channels of the cellular array except for the channels that are notched. The base data transmitting station also transmits a notching pattern, which is continuously updated, to mobile transmitters within the cell. The notching pattern comprises information concerning the channels in the cell that are notched and information concerning used channels of adjacent cells that are notched. The mobile transmitters in the cell will transmit a single data stream over all of the plurality of channels of the cellular array except for the notched channels.

1993

Apparatus and method for overlaying data on trunked radio communications
EP 0566957 A1

ABSTRACT

A data communications system is overlaid on a voice-based trunked radio system (10). Digital data packets are transmitted over available radio channels, thereby enabling data communication between a host dispatch system (100) and mobiles (300) and a base station (200) in the trunked radio system. Radio channels associated with trunked channel groups are accessed when available by a communications controller (201). The communications controller is configured to communicate with various mobile units of the trunked radio system over available radio channels through multiple radio communication link (901). Radio channels are monitored to detect when the radio channels are presently unused for voice transmission and thereby accessible for data overlay. In particular, when the data overlay system detects that the transmission of analog voice information ceases over a particular radio channel, the trunked channel group association of that particular radio channel is caused to be switched from a voice group to a data group. Data packets are then transferred over the available radio channel.