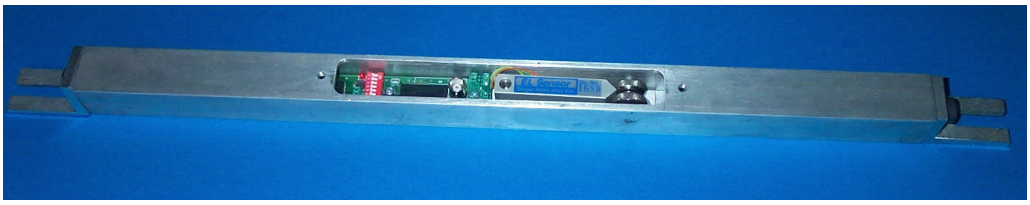
Geotechnical Measurement Solutions

Settlement/Tilt Wireless Measurement Instrumentation Models S/T102-1 & S/T102-2

Embedded Radio Interface
for cable-less solutions
Analogue Output for local data recording operations

Industrial Temperature Range
Low Power Requirements
Compatible To All Keynes Data Loggers



- **Inbuilt Level Zeroing Indicator**
- **Level Status LED's**
- **Microprocessor controlled for increased accuracy**
- **Analogue Output for local measurement**
- **433 and 434 MHz Operation**
- **Solutions to 512 Sensor Channels**
- **250 m Line Of Sight Range**
- **32 Channel Receiver Unit - Model LSI-R102**
- **Directly Compatible to all Keynes Data Acquisition Systems**
- **Battery Life - 1 to 10 years**
- **Solar Power Option available**
- **Automatic Fault Detection System**
- **Resolution to 0.003 Deg**

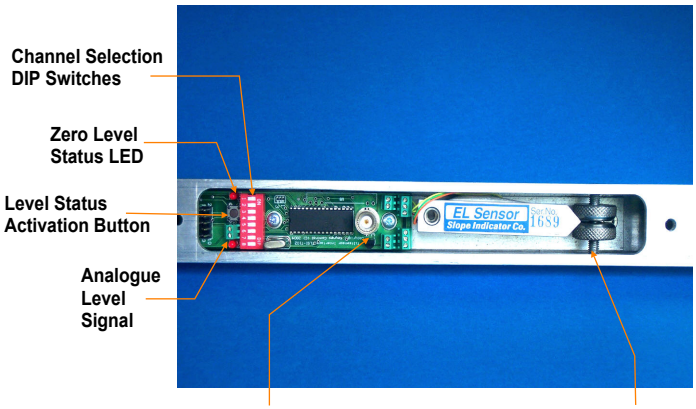


Fig 2

LSI-R102 Receiver Module

The Keynes Controls LSI-R102 receiver module detects signals from the settlement/tilt sensors and translates the sensor signals to analogue output proportional to the tilt angle. Each receiver module supports up to 32 individual sensors. Multiple receiver units can work together and systems up to 512 channels can be seamlessly integrated. The output of the LSI-R102 can be directly connected to all Keynes data loggers & acquisition systems.

Fault Detection System

The LSI-R102 receiver polls for the sensor input signals every 10 minutes and any sensor that does not respond causes the corresponding analogue output on receiver to drop to 0V. This level change can be used to trigger alarm messages to an operator. The alarm will automatically clear when the sensor signal is returned to operation. Alarm messages can be sent to users locally on a LAN and remotely across the Internet when operations are combined with Keynes Logger Units.

Introduction

The Settlement/Tilt sensor is based around the Slope Instrumentation range of EL Sensors attached to a rigid metal beam with adjustable mounting attachments. The tilt sensor is a precision bubble device that varies in resistance depending upon its angle of tilt and is used as part of bridge circuit. As the sensor tilt angle varies the output of the bridge changes level in proportion to movement. The rigid metal beams are typically 1 to 2 metres in length and can be deployed in both the horizontal and vertical planes.

The signal conditioning for the sensor is undertaken by the the Keynes Controls LSI-T102 module which incorporates sensor signal conditioning, analogue signal output, zero level adjustment indicator and UHF transmitter for wireless operations into a single device. The T/S-102 level is adjusted using the Thumb Wheel Leveling Screws.

Operations

Once the the bar is mounted to the surface to be monitored, the radio antenna attached or the unit connected to a local logging device then upon activating the level status button the sensor will indicate which direction the level sensor is to be adjusted to zero the device. Once both level status LEDs are illuminated the tilt sensor is perfectly level. After a timeout period of 1 minute the sensor status LEDs will be powered off to minimise power. The zero level can be further adjusted if necessary by simply reactivating the Level Status button. The analogue output channels on the LSI-R102 receiver module only changes level when there is a change in the sensor signal levels even though the sensor itself may be sleep mode prior to making a fresh reading.

Channel Selection

Each LSI-T102 module contains 8 DIP switches for selecting the channel to be used. Each sensor must have a unique channel number assigned when used with the radio interface.

The LSI-R102 receiver module contains 5 channel selection DIP switches that are used to select the sensors in blocks of 32 channels. The channel selection on the sensor also defines which output on the receiver is used to provide the signal to the data logger or display unit.

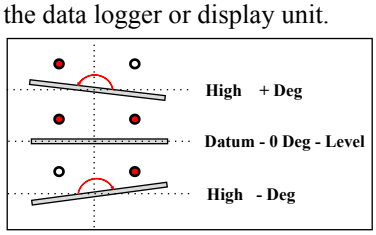


Fig 3 shows the operation of the Zero Level Status LEDs. When both LEDs are illuminated then the sensor is perfectly level at 0 Deg.

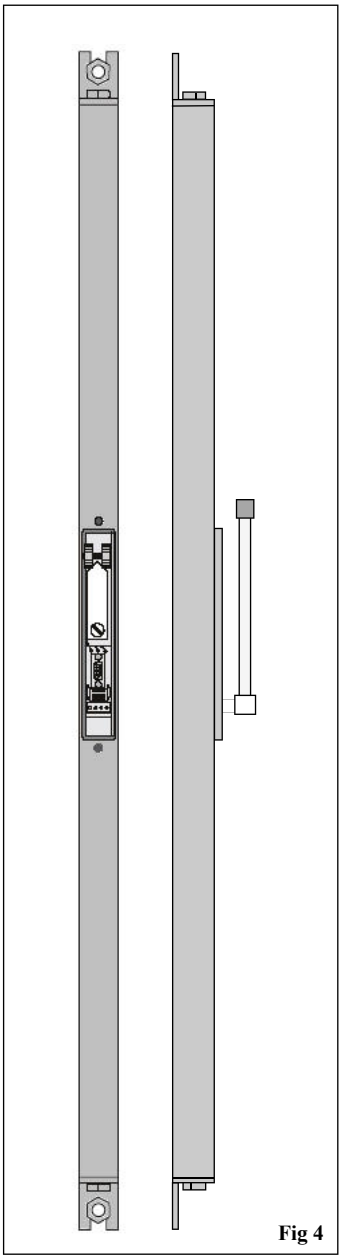


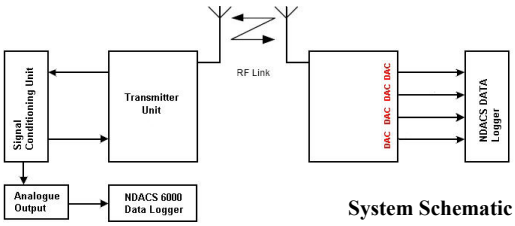
Fig 4

Reliability: The T/S-102 family of sensors uses no moving parts and is supplied with an industrial temperature range making it ideal for operations in most weather conditions. With no moving parts and solid state construction make the sensor a very reliable tool.

Local Operations: The T/S-102 range of sensors contains both a radio interface and local analogue output for local measurements. The local analogue output can be used for direct connection to recording systems to and to display units where readings are needed instantly.

Cost Effective: The sensors are easy to install and utilising the embedded transmitter they can be fitted without need of any external wiring. The sensors are fast to deploy and easily integrated to measurement systems. For local operations the analogue output can be used to see instantly the actions of the sensor.

Microprocessor Control: The T/S-102 sensors utilise microprocessor control for improved timing accuracy and minimise the data acquisition system noise.



System Schematic - Fig 5

Power Supply

The T/S-102 range sensors can be supplied with a range of battery packs. The capacity of the battery pack details the period of time over which the sensor can be deployed. Battery packs are available allowing the instruments to be deployed remotely for a number of years.

It is also possible to deploy the T/S-102 sensor with a solar cell to provide power. In this configuration sensor will operate indefinitely.

Readout & Data Loggers

NDACS range of data loggers all of the Keynes Controls real-time Ethernet data acquisition systems can be connected to the range of Settlement/Tilt senors. The LSI-R102 receiver module can accept upto 32 sensors and pass information directly to 2 x 16 channel NDACS data recorders. The NetPod 4000 range of Ethernet data acquisition systems can accept up to 96 sensors to a single instrument. The data loggers can be used to report data automatically across networks, the Internet and remotely by direct data connection or by E-mail across dial-up ISP accounts.

See **http://www.keynes-controls.com/ndacs6016productsheet.htm** for further details of the NDACS data recorders.

NDACS 6000 Series Data Recorder

The NDACS 6000 series of loggers can be used to record tilt and displacement directly from the analogue output from the T/S-102 range of sensors and from any associated temperature sensors such as thermocouple and RTD.

Deployment

The T/S-102 range of sensors can be directly connected to data recording systems via the analogue output or via the radio interface. The LSI-T102 signal conditioning module utilises a standard UHF BNC connector to connect the transmitter to a suitable antenna. A range of antennas are available from standard weatherproof rubber helicals for local operations to beam antennas for longer distance applications.

T/S-102 Settlement/Tilt Sensor Specifications

The following specifications are those achieved when using the LSI-T102 signalconditions & transmitter unit. Range specification is based upon clear line of sight between T/S-102 sensor and receiver unit LTI-R102

Physical Dimensions	Beams are 38 x 38 mm aluminium section
Options for	1m & 2m lengths including end brackets
Operating Temperature Range	-20 to +65 Deg C
Storage Temperature Range	-20 to + 75 Deg C
No Measurement Axis	1
Power Supply	+4.5 to 9 V DC
Standby Power Requirement	200 uA
Active Power Requirement	30 mA
RF Frequency	433 - 434 MHz
Antenna Impedance	50 Ohm
RF Power	10 dBm 50 Ohm Load
FM Deviation	64 KHz
Data Rate	19.2 Kb (default)
Range	± 40 Arc Minute (±0.66 Deg) 11mm/m (1.3 degree total range)
Repeatability	± 3 Arc Seconds 0.00083 Deg
Wireless Sensor Resolution	0.1% of total range 0.0013 Deg (4.7 Arc second)

LSI-R102 FM Receiver Specifications

The following specifications are for the LSI-R102 FM receiver unit. The physical dimensions are accurate at the time of publication however the operational performance will depend on suitably locating the T/S-102 sensor transmitters.

Operating Temperature Range	-20 to +65 Deg C
Storage Temperature Range	-20 to + 75 Deg C
No. Analogue Outputs	32 Full Differential
Output Range	2V ± 1V
Power Supply	+6 to 12 V DC
Rated at	50 mA
RF Frequency	433 - 434 MHz
Antenna Impedance	50 Ohm
Sensitivity	-105 dBm
Physical Dimensions	112 x 62 x 60 mm
Fitting	DIN Rail Mounting
Antenna Connection	BNC

Figure 4 shows a profile of the T/S-102 sensor fitted with the low profile general purpose antenna

Part Numbers

T/S-102-1m	**1m length Settlement/Tilt Beam Sensor**
T/S-102-2m	**2m length Settlement/Tilt Beam Sensor**
LSI-R102	**32 Channel DIN Rail Mounted Rx Unit**

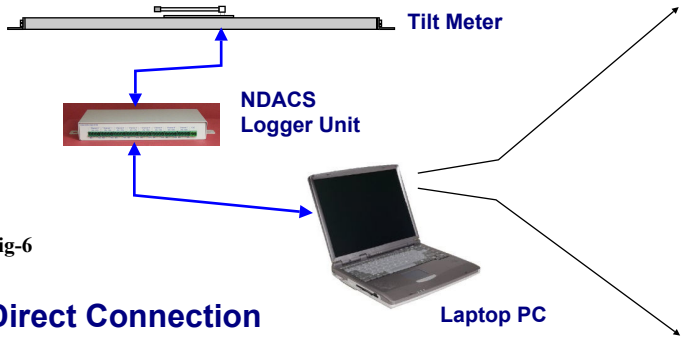


Fig-6

Direct Connection

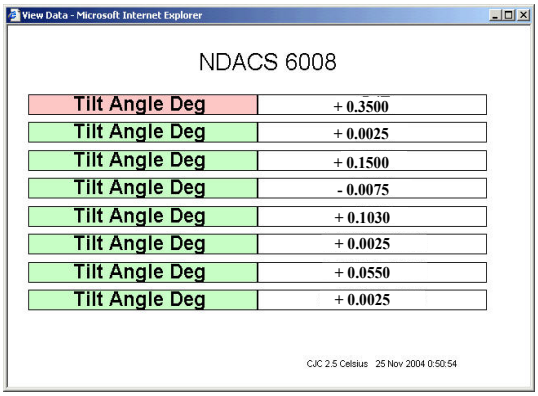
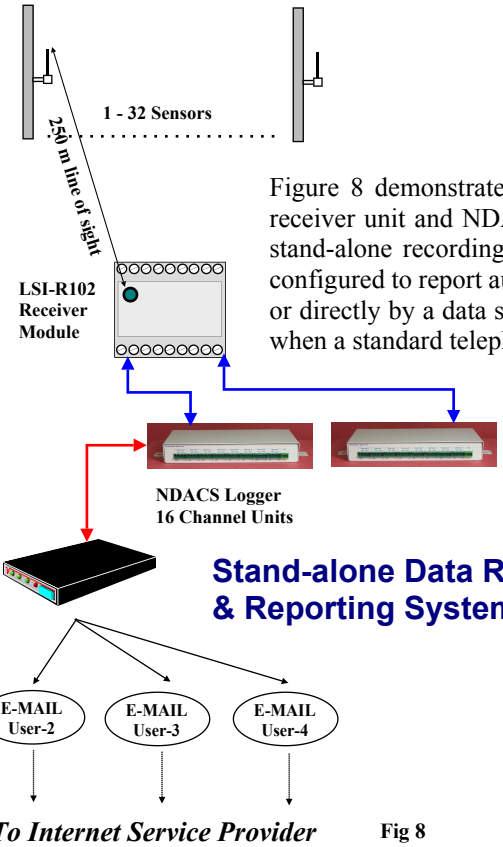


Fig-7

Figure 6 and 7 shows the T/S-102 sensor directly connected to theN-DACS logger for local stand-alone data recording operations. When used in conjunction with the NDACS logger a laptop PC can be used to observe real-time information and download archived data. The same real-time display is presented to the User no matter which communication interface is in use.



Stand-alone Data Recording & Reporting System

Fig 8

Figure 8 demonstrates the configuration of the LSI-R102 receiver unit and NDACS logger units for use as a remote stand-alone recording system. The instrumentation can be configured to report automatically via a dial-up Internet link or directly by a data server. A wireless modem can be used when a standard telephone line is not available.

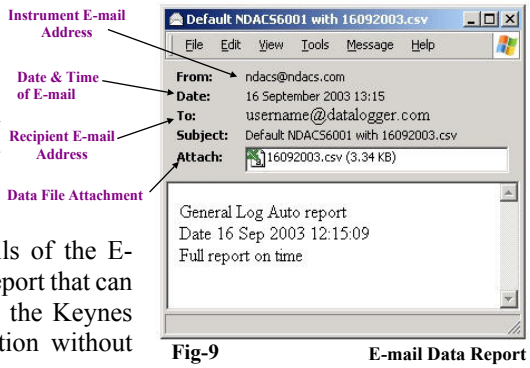


Fig-9 E-mail Data Report

Figure 9 shows details of the E-mail automatic data report that can be sent directly from the Keynes Controls instrumentation without the use of a local PC.

E-mail Alarm & Auto Report Format

The NDACS 6000 utilises a standard E-mail format for sending alarm and automatic report data. It is possible to send E-mail messages from the instrument to a maximum of 4 users simultaneously and this can be expaned using the E-mail account mail box options.. The Automatic report data files are CSV format and can be read directly by most Windows packages such as Microsoft Excel, Word etc.. Each E-mail alarm or record in the data files are time stamped and use the following data format:

Date,HH:MM:SS,Chan-0,Chan-1,Chan-2,Chan-3,.....

Figure 10 demonstrates how a large number of sensors are combined into a single instrument system. The LSI-R102 receivers can all be grouped together and only interpret signals from their specified sensors. The output from the LSI-R102 is passed to a network of NDACS loggers or NetPod 4000 instruments depending upon the application.

As long as T/S-102 sensors are deployed within the range of the receiver then data with be acquired. The T/S-102 can also be directly connected to the Keynes data acquisition systems if required.

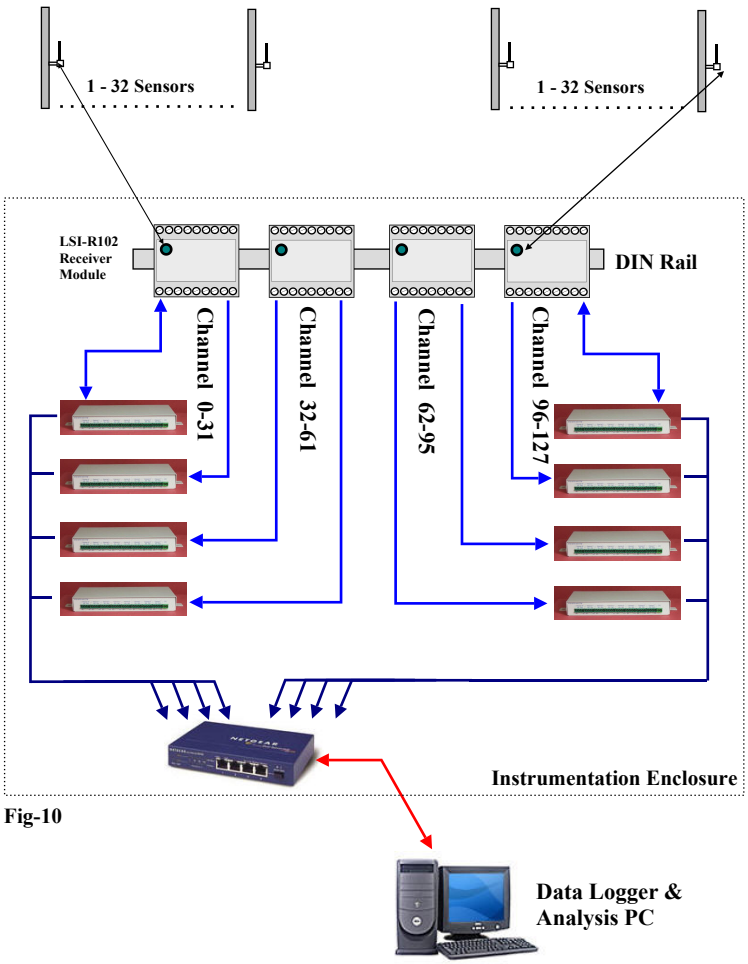


Fig-10

Large Channel Count System For Local Operations

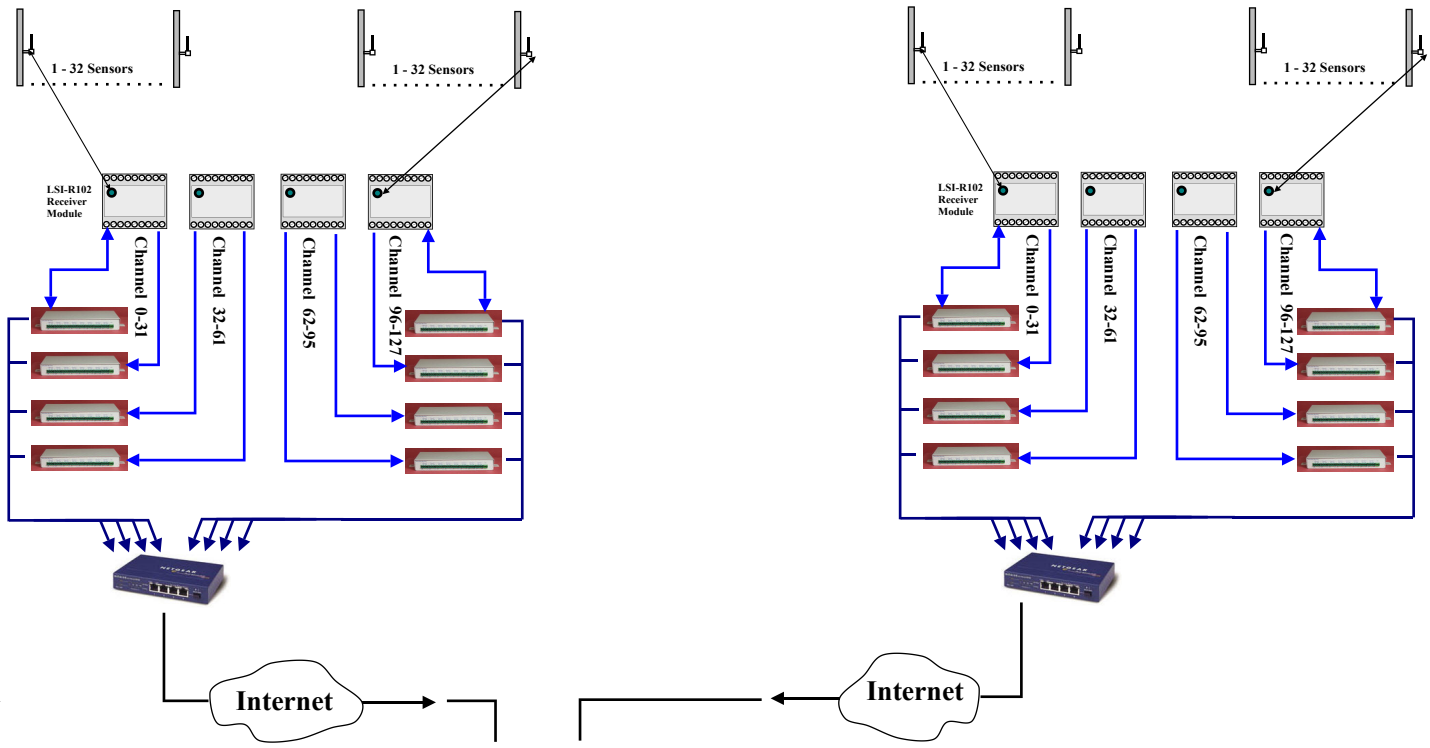


Fig-11

Internet Distributed Application

Figure 11 shows how widely distributed systems can be connected together using the Internet to route data over long distances. This feature enables large scale applications at multiple locations to report data back to a central point for analysis and storage.

Figure 12 demonstrates how a large scale application at multiple locations can be achieved using a local area network and the radio interface of the T/S-102 Settlement/Tilt sensors. The NDACS instruments can be used to read real-time information and to act as a local data storage.

The sensors can be directly connected to the NDACS instrumentation when the use of the radio interface is not necessary.

Other Keynes Systems such as the NetPod 4000 can be used where large channel counts at a specific location is desirable.

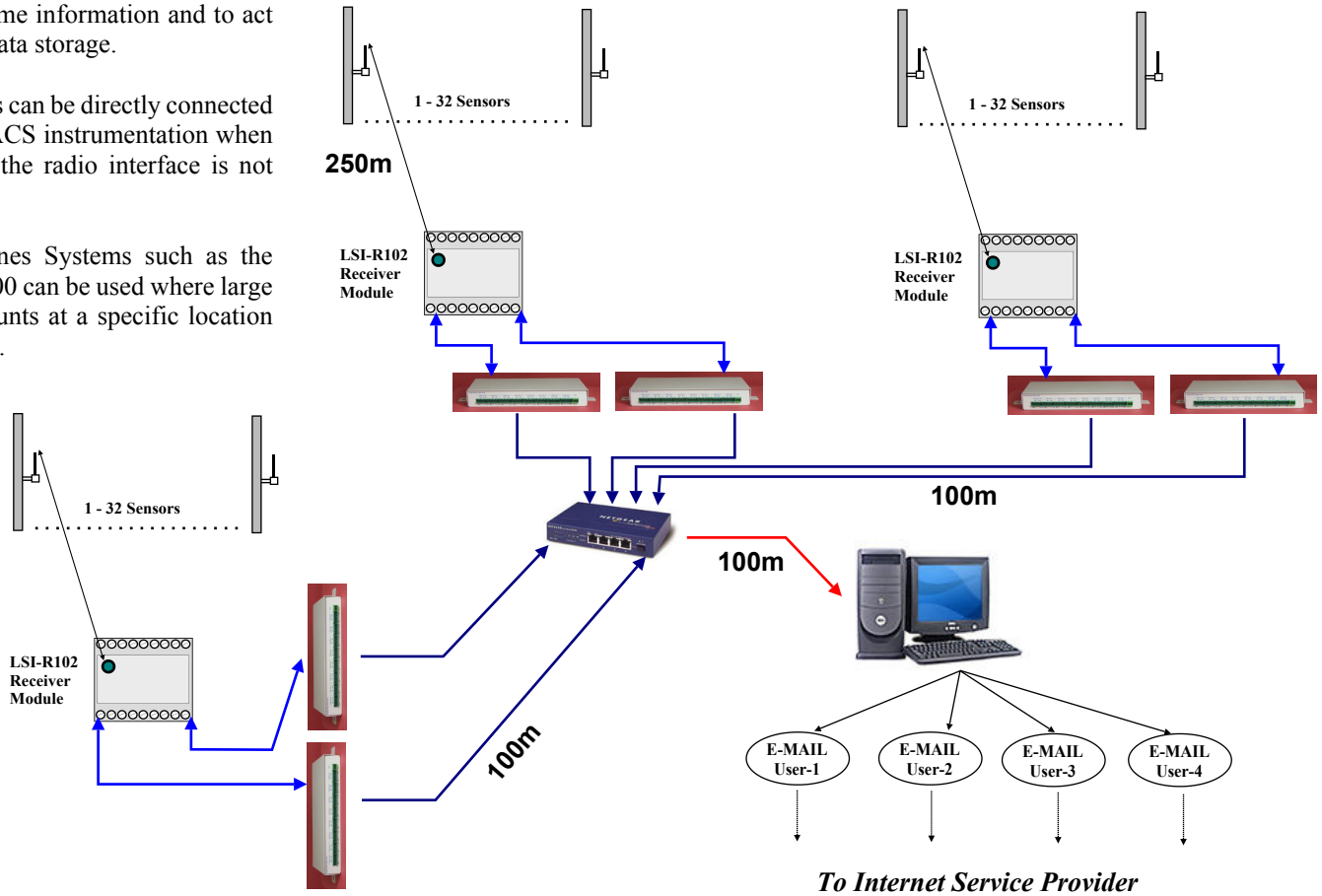


Fig-12

Distributed Large Scale Local Area Network Application