

## Handbook

### ClearFill®Star CDMA





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Please send your remarks to:

RFS GmbH  
Kabelkamp 20  
D-30179 Hannover  
Phone: +49 511 676-2731  
Fax: +49 511 676-2515  
Email: [techinfo.europe@rfsworld.com](mailto:techinfo.europe@rfsworld.com)

[www.RFSWorld.com](http://www.RFSWorld.com)

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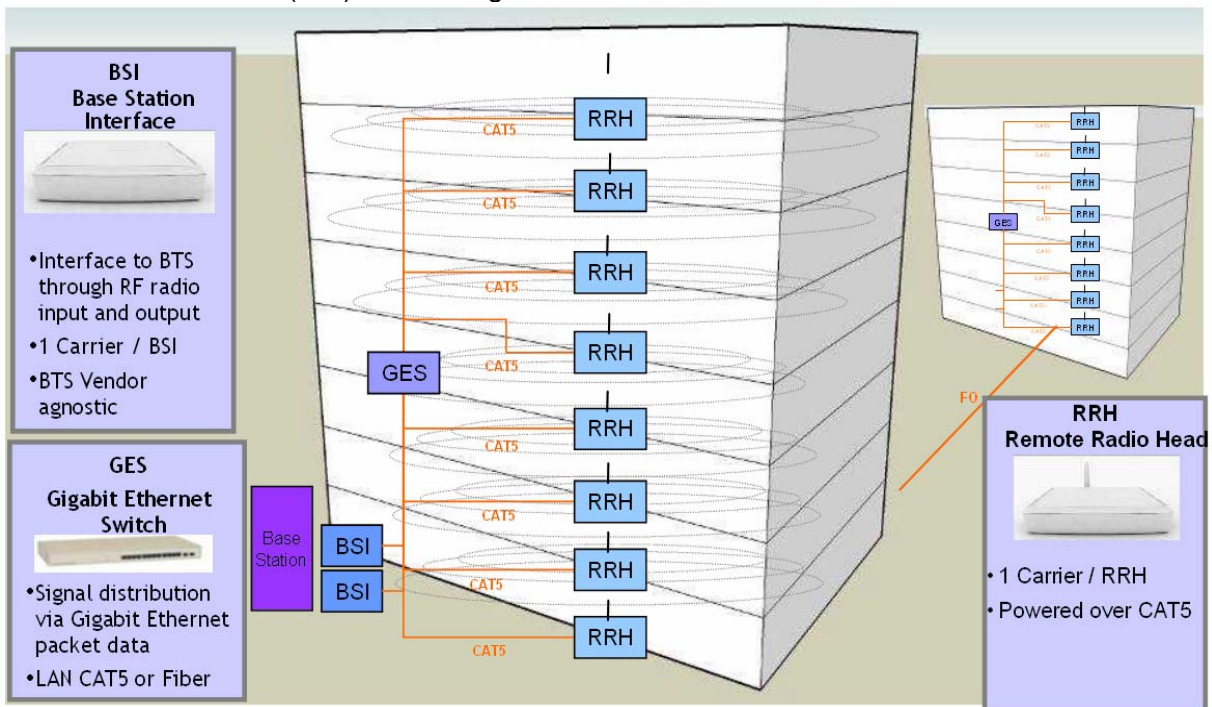
# 1 Introduction

This document describes the ClearFill®Star system and its components.

## 1.1 General

ClearFill®Star is an innovative, digital, IP-based wireless indoor coverage solution. ClearFill®Star is a unique low-cost approach that improves indoor cellular service by converting radio coverage into an IP based Ethernet application. It is based on wireless, Ethernet, and packet technology. This in-building cellular solution uses standard LAN cabling (CAT5), switches, routers, and network administration which are already installed in most office buildings, making ClearFill®Star simple and inexpensive to deploy, maintain, and reconfigure.

Indoor coverage will be provided by ClearFill®Star indoor remote radio heads (RRH) powered over Ethernet, indoor capacity is defined by the number of ClearFill®Star base station interface units (BSI) connecting to BTSs/NodeBs.



**Figure 1 ClearFill®Star system component distribution**

This solution allows distributing the RF signals from a base station via a Gigabit Ethernet Network. The system digitizes and packages the RF signal of a base station and distributes it over an Ethernet network.

ClearFill®Star splits coverage- and capacity functionality. This feature allows to extend capacity at only one central point and to allocate the resource to different RRHs, according to demand. This concept makes the system highly scalable and flexible.

The BSI RF interface makes the whole solution BTS vendor agnostic.

## Advantages of ClearFill Star system versus a typical distributed antenna system:

### Lower costs for hardware and installation:

- Installation costs are reduced by the use of existing infrastructure.
- All remote radio heads / active antennas (RRH) are powered via CAT5 cables and the Power of Ethernet (PoE) functionality that eases the installation considerably.
- CAT5 cable (+fiber) versus coaxial cable (+fiber).
- Gig-E components versus RF components.
- Solution is future proof, because the used transport medium will evolve with Ethernet evolution; 10 GBit Ethernet solutions are already entering the market.
- Costs are competitive due to huge Ethernet market: the benefit is a massive economy of scale.

### Higher flexibility:

- Ability to adjust output power per RRH via software.
- Supports diversity and sectorization for increasing capacity without additional hardware.
- OA&M functions are integrated in same Gig-E network.
- Conversion between fiber medium and CAT5 medium is done easily.
- System is flexible and scalable.

### Higher performance:




- Highest quality of service; due to digitization of the RF signal directly at the source no degradation of the signal due to distribution.
- Digital transport does not degrade RF signal quality.
- Elimination of gain uncertainty in the system.

### Capacity and coverage are independent with ClearFill@Star:

- 1 sector worth of capacity can be distributed to multiple RRHs covering a large area or a single RRH covering a small area resulting in a very flexible growth.
- Capability to manage base station capacity. The software assigns Remote Radio Heads (active antennas) to base station or base station sectors.
- Softer and soft handoff features are preserved.

Welcome to the next generation of active Distributed Antenna Systems, welcome to ClearFill@Star!

## 1.2 Conventions in this Manual

	This check mark means there is a note of interest and is something you should pay special attention to while using ClearFill®Star.
	This exclamation point means there is a caution or warning and is something that could damage your property of ClearFill®Star.
	This question mark provides you with a reminder about something you might need to do while using or administrating ClearFill®Star.

## 1.3 Standards Conformance

The following Standards are applicable to ClearFill®Star:

- FCC                               FCC part 15/ 22/ 24
- IC                                    RSS-210 / RSS-131
- Safety                            IEC / EN60950-1
- Ethernet                        TIA/EIA 568-A
- PoE                                IEEE 802.3af
- RF Performance                3GPP2 C.S0051-01

Refer to Chapter 11 for compliance information.

## 1.4 Firmware Release

For the latest Firmware release and associated documentation, access the RFS Internet Homepage at:

[www.RFSWorld.com](http://www.RFSWorld.com)

or contact

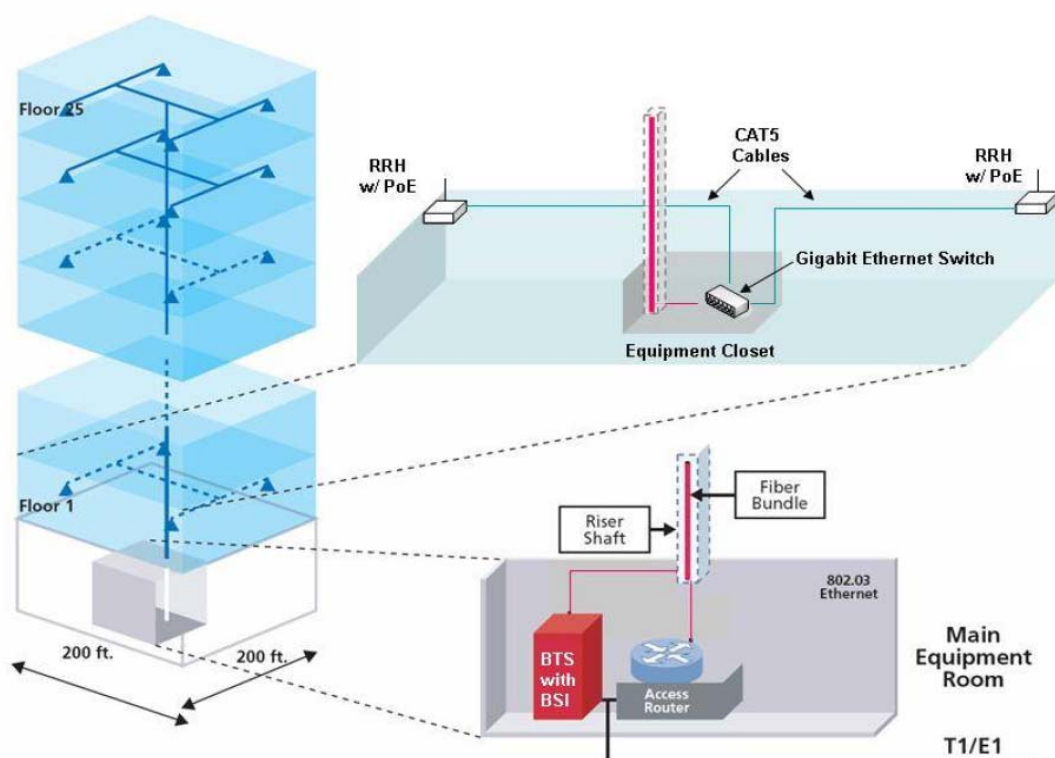
[techinfo.europe@rfsworld.com](mailto:techinfo.europe@rfsworld.com), or [applications.engineering@rfsworld.com](mailto:applications.engineering@rfsworld.com)

## 2 ClearFill®Star System Description

### 2.1 General description

In order to leverage the commonly available data network infrastructure, ClearFill®Star uses the same local area network (LAN) topology.

A LAN in a typical office building is laid out in a tree topology. The base of the tree is the main telecommunication/equipment room with the Ethernet switches and routers. It usually accommodates the connection to the outside world. From this central location network cables (fiber or CAT5) branch to multiple telecommunication/equipment closets located throughout the building. The telecom closets that are spread over the building are connected as the last level of branches. They connect each individual location that needs network access with CAT5 cables. The telecom closets are usually located so close that the longest CAT5 cable is less than 100 m (300 ft) long in order to support 1000Base-T Ethernet. An example is illustrated in Figure 2.



**Figure 2 Typical deployment topology of a ClearFill®Star network**

This topology is also used for ClearFill®Star. The base station (BTS) is usually located in the main telecom room. A base station interface (BSI) card connects to the BTS. Fiber or CAT-5 cables connect the BSI to multiple Gigabit Ethernet switches (GESs), installed in wiring closets all over the building. These switches are connected by CAT-5 cables to the individual remote radio heads (RRHs), installed at desired locations throughout

the building. One or more external antennas can be connected to an RRH through a short RF cable or directly on the housing. Power for the RRHs is provided over CAT-5 cables using the power-over-Ethernet (PoE) 802.3af standard. Figure 3 shows a schematic signal flow from BTS to RRH.

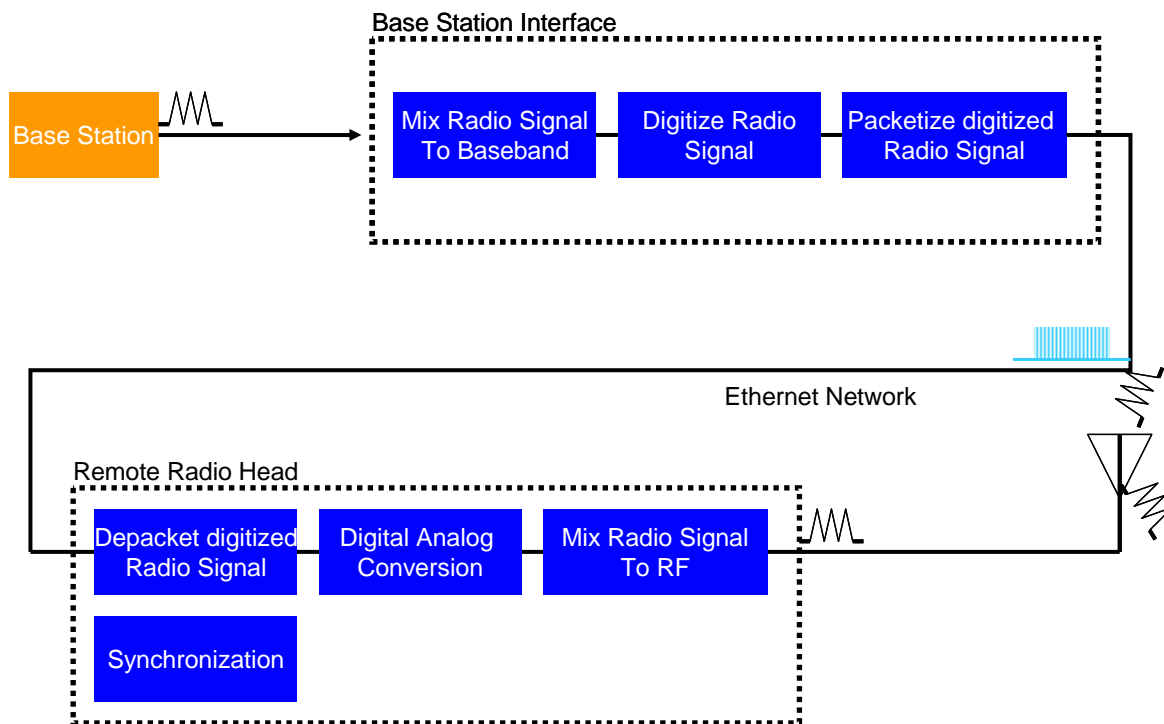



Figure 3 Signal flow of ClearFill®Star


	<p>Each system element of the ClearFill®Star system is described in detail in section 2.2.</p>
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### 2.1.1 Supported Services

The ClearFill®Star system supports the following services:

- CDMA2000 1xRTT systems complying to C.S0002 up to and including Release A
- EvDO Release A 1.25 MHz applications
- Frequency Band Class 0 (800 MHz band, sub-bands 0,1 and 2)
- Frequency Band Class 1 (1900 MHz band)

### 2.1.2 Identification of System

	<p>This chapter gives a short overview of the ClearFill®Star components. Please see chapter 2.2-Unit description for a more detailed description of each system element.</p>
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#### 2.1.2.1 Point of Interconnection (POI)

The POI attenuates the RF signal of the base station to the input/output system requirements of the BSI, e.g. when a base station with 2 carriers per sector is used the POI has the function to split the RF signal into two paths to provide an RF signal to the two required BSIs.



Figure 4 Point of Interconnection (POI) device

#### 2.1.2.2 Base Station Interface (BSI)

The BSI is the interface between BTS and Ethernet Infrastructure. Its function is in downlink (DL) to digitize and packet the RF signal of the base station according to Ethernet standard. For the uplink (UL) the BSI translates the digitized packet stream back to RF.



Figure 5 Twin Base Station Interface (BSI) device

#### 2.1.2.3 Remote Radio Head (RHH)

The RRHs are indoor RF front-ends. They have 1Gigabit-Ethernet interfaces. An automatic summing function is included in the RRH to sum the UL data streams of several RRHs. Alternatively to the mobile signal coverage function, the RRH can generate up to 7 pilot beacon signals to support the hard handover. An RRH package includes an external, removable antenna.





**Figure 6 Remote Radio Head (RRH) device**

#### 2.1.2.4 Ethernet Infrastructure incl. Gigabit Ethernet Switched (GES)

The infrastructure for data transport is based on 1Gigabit Ethernet Switches (GES). Two kinds of cables can be used for the interconnection: CAT5 (or higher) for distances of maximum 100m (300ft) and optical fibers for longer distances. The GES support Power over Ethernet (PoE).



**Figure 7 Gigabit Ethernet Switch (GES) device**

#### 2.1.2.5 Network Management System (NMS) Server

The NMS is in charge of:

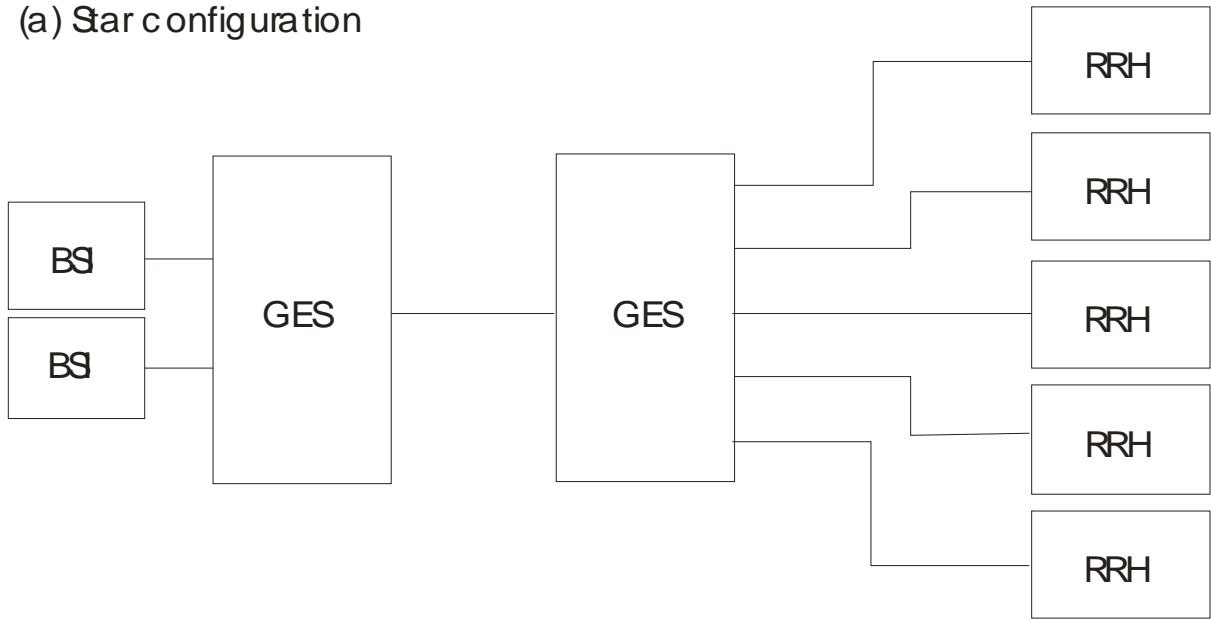
- Configuring the network elements
- Mapping of RRH to BSI
- Operation and administration
- Supervision of system (monitoring and control functionality)
- Maintenance of system

#### 2.1.3 System Structure (deployment architectures)

ClearFill®Star allows building a star configuration (see Figure 8(a)), i.e. all RRH of the same sector reside on the same switch level. It also allows a tree configuration (see Figure 8(b)), i.e. RRHs of different sectors may reside on different switch levels.



(a) Star configuration



(b) Tree configuration

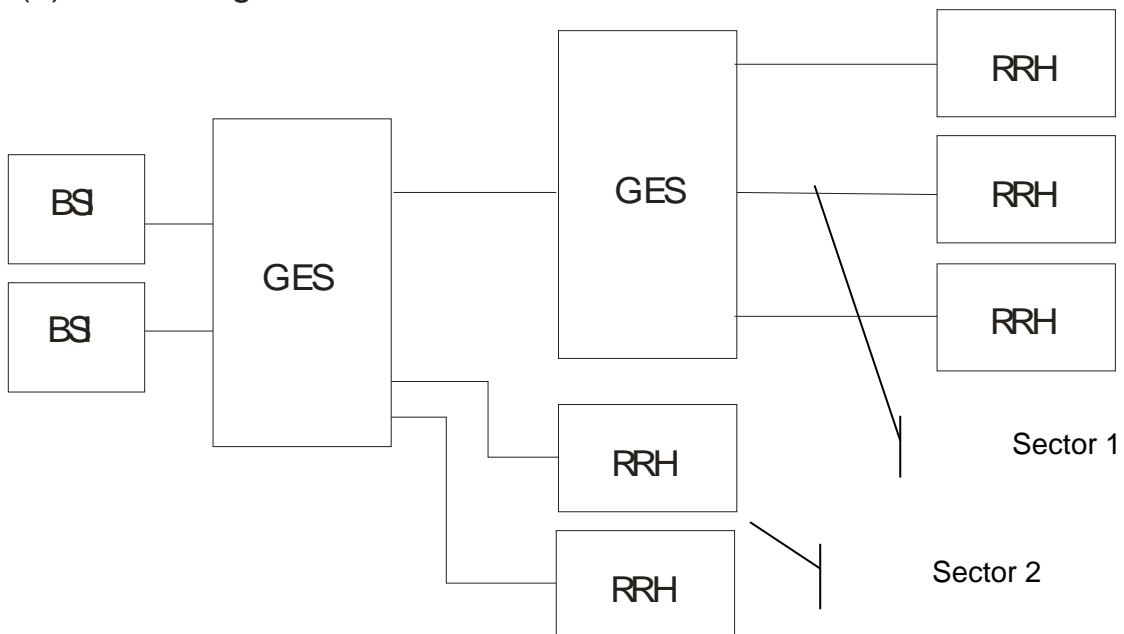


Figure 8 General deployment architectures: (a) star configuration (one sector with 5 RRH) and (b) tree configuration (sector 1 with 3 RRH, sector 2 with 2 RRH).

## 2.2 Unit description

### 2.2.1 Base Station Interface (BSI)

The connection to the BTS is established through an RF interface. The RF interface allows ClearFill®Star to support any manufacture’s BTSs. The central task of the BSI is to convert the downlink radio signals into outgoing Ethernet packets and to convert incoming Ethernet packets into uplink radio signals.

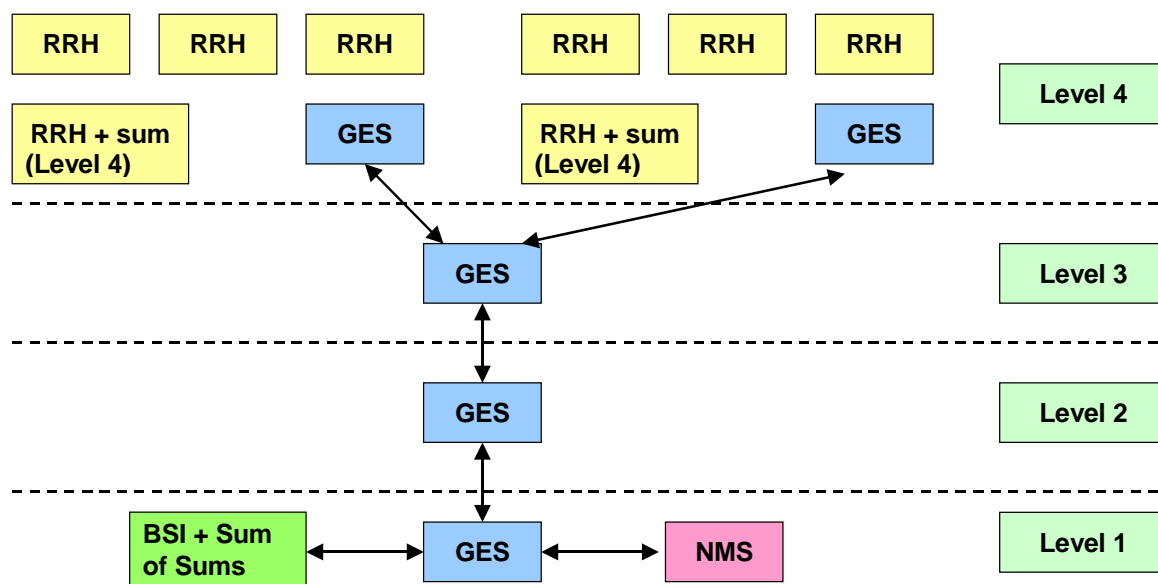
The BSIs RF interface processes the downlink RF signal with a down-converter and an analogue-to-digital converter (ADC) to generate a digital base band signal.

The uplink data is processed by a digital-to-analogue converter (DAC) and an up-converter.

To support multiple sectors a ClearFill®Star network can easily support multiple BSIs.

For the uplink, multiple packet streams from multiple RRHs are combined by summation to form a single IQ signal stream for the BTS receiver. This feature is called summing. A summing function is included in the BSI, an example for the summing function is shown in Figure 9.

**Transport Network of a 4 Cascade Configuration**



**Figure 9 Example of a cascaded transport network.**

The BSI described in this manual is the CFS-BSI-2S-819-1, a simplex twin BSI rack. It consists of two BSIs, which are independent units in a single housing. All connections (RF, Ethernet, power supply) are realized for each BSI independently.

The simplex twin BSI rack supports a carrier capacity of 2 CDMA carriers (realized via two separate BSI in one housing).

- The Simplex Twin BSI can be fed by two external power supplies (one for each BSI).
- The external power supply port is at the rear side of the housing.
- Minimum spacing of two RF channels that are supported: 2.5MHz.
- The frequency band and channel allocation are controlled separately for each BSI unit via NMS.
- LEDs indicate the BSI status for each BSI unit independently (locally).

### 2.2.2 Remote Radio Head (RRH)

The RRH converts incoming Ethernet packets into downlink RF signal to radiate it out to the mobiles. Receiving uplink signals from the mobiles are converted into outgoing Ethernet packets. The RRH synchronizes its frequency and timing to the BSI/BTS. The RRH is powered over Ethernet to eliminate the requirement of an AC drop for installation, which provides significant cost saving. To strive for low equipment cost, the RRH uses handset technology for its RF transceiver function.

The summing function is implemented in each RRH. When activated a group of RRHs send their packets to a designated RRH, which combines them with its own uplink data to form a signal stream to be sent to either the BSI or another summing RRH. By locating the summing function in the BSI and RRHs, an off-the-shelf Gigabit Ethernet switch can be used in the ClearFill®Star network.

### 2.2.3 Gigabit Ethernet Switch (GES)

An Ethernet switch directs data packets to their destination by using their MAC address. In a ClearFill®Star network, Gigabit Ethernet is used because of the required data rate and latency. The switches need to support VLAN and priority switching. Commercial off-the-shelf GES could theoretically be used as data transport network, but special MIB files would have to be implemented in order to be able to connect NMS to the GES. Therefore, the ClearFill®Star end-to-end solution offer includes a GES released to operate with BSI and RRH. The switch can also be used to source DC power for the RRHs over the CAT5 cables using the POE standard.

Gigabit Ethernet is required due to the link to link synchronization that is essential for the overall system synchronization.

### 2.2.4 Supported Ethernet Standards


The distribution of signals between BSI-GES-RRH and GES-NMS is done via Gigabit Ethernet Network in accordance to the protocol specified in ClearFill®Star.

The distribution of signals between GES-GES is done via Gigabit Ethernet Network in accordance to the standards defined in Table 1.

Name	Medium	Distance
1000BASE-T	unshielded twisted pair	100 meters (300 ft)
1000BASE-SX	multi-mode fiber	500 meters (1500 ft)
1000BASE-LX	single-mode fiber	5 km (3 mi)

**Table 1 Ethernet Transport Media**

Signal distribution between other entities (e.g. BTS-POI, POI-BSI, and RRH-antenna) is realized by RF connection.

	<p>It is possible to operate WLAN on the same physical infrastructure depending on the ClearFill®Star-CDMA system, as long as the system performance of both VLANs (ClearFill®Star and WLAN) is not degraded.</p>
---	---

## 2.3 Features

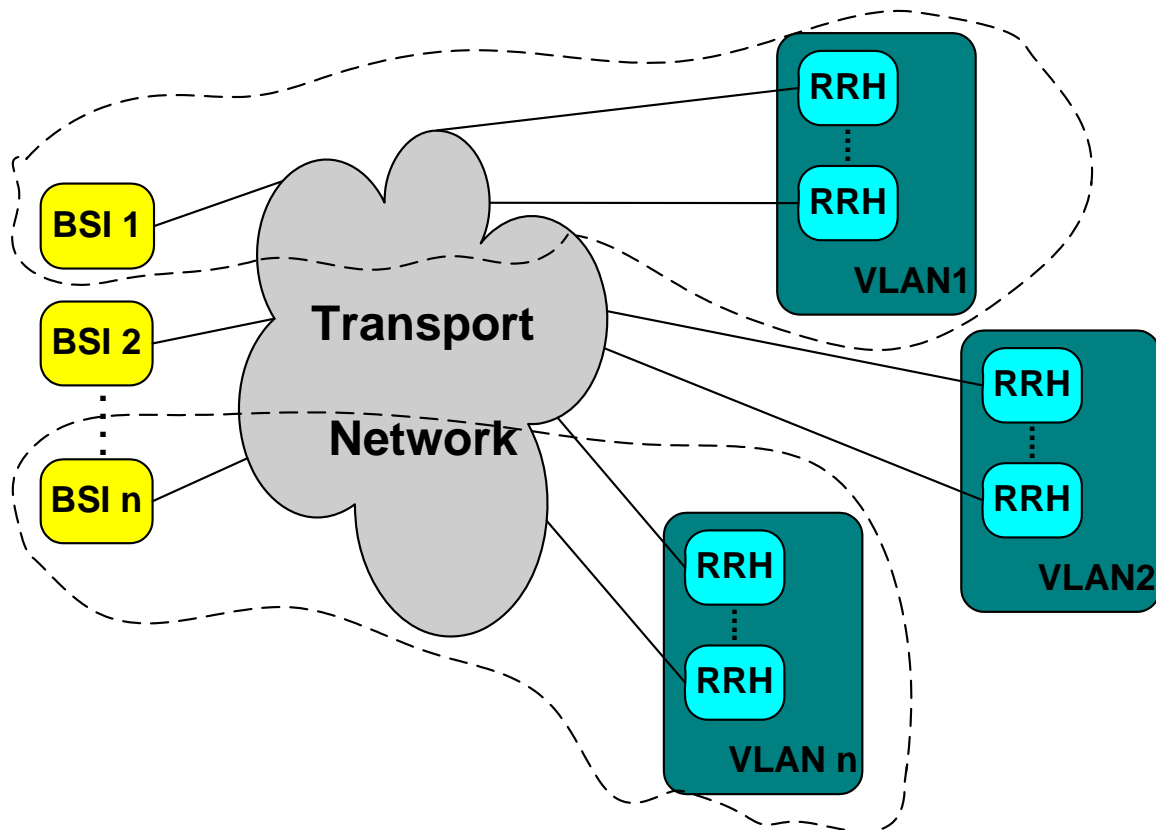
### 2.3.1 General Features

- A BSI / RRH supports one single CDMA RF carrier. It provides sufficient rejection against adjacent carriers.
- The system uses Ethernet protocol for the communication between BSI, RRH and switches.
- The summing function summarizes the capability to transform a number of incoming independent data streams in a single data stream.
- The RRH contains a summing function. It combines in UL the data stream of up to 8 RRHs (7 RRH + itself).
- The BSI contains a summing function. It combines in UL the data of up to 8 data streams.
- The maximum number of supported RRHs in a system configuration with one BSI is 16.
- The system supports 2 summing levels (1x BSI, 1x RRH).
- The transport network consists of up to 4 cascaded GES.
- It is possible to install a pre-configured RRH in a running system (e.g. when a RRH is disconnected and re-connected afterwards).
- A RRH, which has not been configured, will initialize in the NMS and start-up in idle mode with default values (factory settings). It starts in online mode without transmitting.
- It is possible to adjust the maximum output power of the RRH via the NMS and remote control of the NMS in 1 dB steps.
- The system is capable to upload new SW releases via the network management center.
- Ethernet network operates via CAT5- or fiber links both supporting data rates of 1Gbit/s.
- The monitoring and configuration of the network elements is realized by the NMS.

### 2.3.2 Sectorization

The sectorization is configured via the GES. The procedure for VLAN configuration is described in section 4.7.3.4-VLAN Configuration of GES.

- In a system containing several BSIs the assignment of each RRHs to a BSI (sectorization) is configurable by VLAN (Figure 10).
- The VLAN configuration / sectorization is done via NMS.



**Figure 10 Illustration of CDMA channel assignment to RRH via VLAN.**

The system supports:

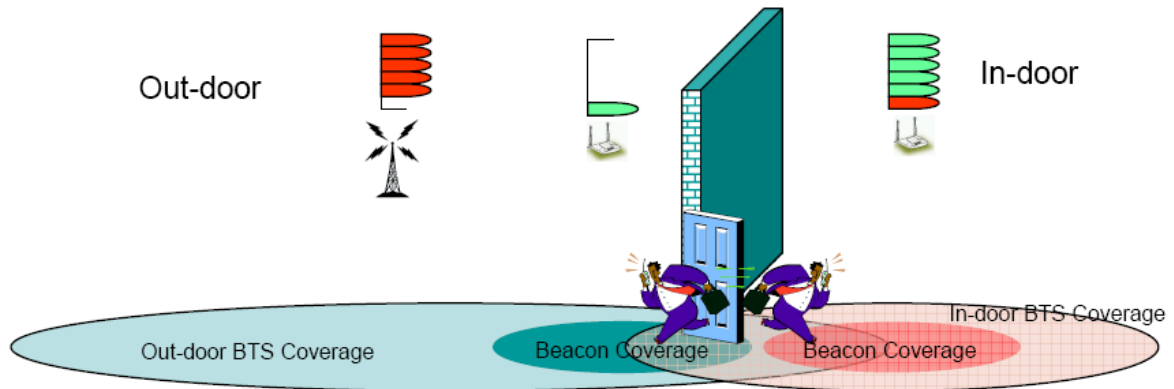
- Port-based VLAN
- IEEE802.1Q Tag VLAN
- 256 active VLANs
- VLAN ID 1~4094

Note: Each RF carrier needs an individual VLAN, consisting of one BSI and a number of RRHs. The maximum number of RF carriers transported on the same Ethernet is limited by the maximum data rate of 1Gbit/s.

### 2.3.3 Guided Hard Handover (Pilot Beacon Functionality)

The RRH has to be able to generate a pilot beacon signal in order to guide the hard handover.

The guided hard handover is accomplished by a pilot beacon generated by the RRH. A typical realization of the guided hard handover from/to 5 outdoor carriers to/from one dedicated indoor carrier is shown in Figure 11.



**Figure 11 Illustration of a typical in-building deployment scenario with pilot beacons**

- One RRH is able to provide up to 7 adjacent pilot beacon signals simultaneously.
- The RRH can either generate one or more pilot beacons or operate on a communication channel; the switch between the configurations is done by NMS.
- The pilot beacon configuration is realized via NMS.
- Output power level of the pilot beacon(s):
  - The Nominal output power level per pilot beacon is:  $-20\text{dBm} \pm 1\text{dB}$ .
  - It is adjustable from  $+14\text{dBm}$  to  $-50\text{dBm}$  in 1dB steps composite.
  - The beacon power level depends on the number of beacon signals.
- Configurable parameters via NMS:
  - CDMA frequency band and channel per pilot beacon.
  - PN offset (0 to 512), same for all pilot beacons per RRH.
  - Power level is the same per beacon.

### **3 System Design Guidelines**

#### **3.1 CDMA Basics (in preparation)**

##### **3.1.1 Data (in preparation)**

##### **3.1.2 Voice (in preparation)**

#### **3.2 Required information for system design**

A successful and reliable RF-design is based on many different parameters and assumptions and cannot be described completely in this handbook. The goal of indoor system design is to meet the requirements for excellent performance and QoS.

**Understanding requirements should include, but not be limited to:**

- Capacity vs. coverage
- Current and future needs
- Timeline for implementation
- Customers expectation

**The essential key information for a proper system design:**

- Coverage area
- Building details
- Expected traffic
- Frequency plan
  - Pilot pollution issues
  - Carrier to Interference Ratio

##### **3.2.1 Power level**

A main parameter for the system design is the required signal strength level.

The minimal required signal strength level should be selected in accordance to the on site conditions. There are several parameters to take into consideration.

Typical values for the min. required signal strength level are in the range of -80dBm to -85dBm for Common Pilot Channel (CPICH).

Other present cells (usually strong outdoor cells) may require to increase the signal strength level at least 10dB (-70 to -75dBm for CPICH).

In CDMA systems, the indicated minimum signal strength level refers to the CPICH, representing the most important parameter for the RF-designer. It is essential for a proper connection that the mobile can receive a dominant CPICH; otherwise poor quality of service occurs (QoS).

Poor QoS results in dropped calls, poor voice quality and poor data throughput.

High signal strength level needs more active equipment resulting in higher costs for the system.

### 3.2.2 Coverage area / Architecture drawings

For optimizing a system design it is essential to have knowledge about the areas to be covered.

A typical indication for the area to be covered is the reception probability:  
-85dBm@95%RP means that 95% of the Building has to get covered with a signal strength level better -85dBm.

Typical values for the minimum signal strength level are in the range of 85dBm to 95dBm, a reception probability of 98% represents a very high demand.

Building drawings showing the structure of the floors or levels and can be useful to evaluate type and structure of the walls and other constructions inside (pylons, elevators, stairs, etc). This is very important for the calculation of the propagation loss which is a main parameter for the link budget.

To prevent insufficient coverage it is very important to analyze losses from walls or obstacles in the design process.

The evaluation of all losses for the propagation path is a critical point, because it is not possible to get exact figures for the RF-attenuation from each wall.

Table 2 shows typical losses for commonly used materials in building constructions.



The following typical wall attenuations were observed:

Type	Attenuation [dB]
Thin concrete wall - 10cm (4 inches)	5
Thick concrete wall - 13cm (5 inches)	13
External wall front with windows	8
External wall front without windows	10
Porous concrete	4
Dry wall, sheetrock	1-2
Wood structure, wood door	1
Glass	2
Concrete floor	13
Brick Wall - 10cm (4 inches)	4
Brick Wall - 6cm (2 inches)	3
Partitions metal	1-2
Plastic structure	0.5
Glass with metal grid	8

**Table 2 Typical attenuation for different materials (source: Wireless Valley)**



Statistical models are helpful if the type of building can be classified:

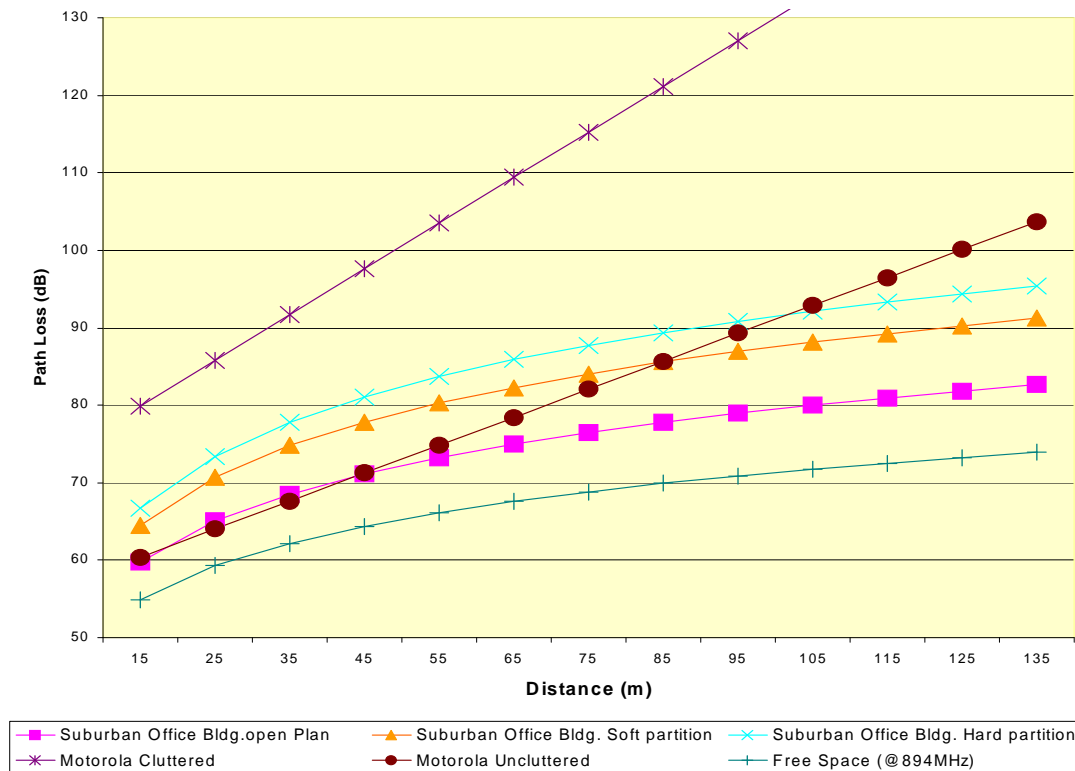
Model Name	Path Loss Equation [dB]
Retail Store	$PL(d) = 22 \text{ Log}(3.28*d) + 20.1$
Suburban Office Bldg - Open Floor Plan	$PL(d) = 24 \text{ Log}(3.28*d) + 19.1$
Suburban Office Bldg - Soft Partitions	$PL(d) = 28 \text{ Log}(3.28*d) + 17.0$
Suburban Office Bldg - Hard Partitions	$PL(d) = 30 \text{ Log}(3.28*d) + 16.0$
University	$PL(d) = 0.6232(d) + 63$
Motorola Cluttered	$PL(d) = 0.594(d) + 71$
Motorola Uncluttered	$PL(d) = 0.3608(d) + 55$
Free Space @ 894 MHz	$PL(d) = 20 \text{ Log}(3.28*d) + 21$

**Table 3 Typical attenuation for different building types (source: Wireless Valley)**

*PL: Path loss (dB)*

*d: Distance from Remote Radio Head to mobile user*





**Figure 12 Path loss models (source: Wireless Valley)**

Nevertheless it is very important to check possible locations for the antennas and the equipment.

- Observe building layout
  - Locations for RF source first
  
- Remote Radio Head Placements
  - Ideal vs. reality
  - Aesthetic issues
  - Suspended ceiling a plus
  - Columns and pillars



### 3.2.3 Type of Building

ClearFill®Star is a confined area coverage solution, applicable primarily to buildings.

Building types:

- Enterprise
- Office building
- Airport
- Residential
- Hotel
- Hospital
- Fairground
- Shopping Mall
- Garage, Car Park area

Building topologies:

- Isolated Building
- Campus areas


Systems for enterprise buildings are more challenging to design due to the construction with concrete walls, concrete pylons and many obstacles like metallic racks, machinery, storage areas, etc.

Office areas, Fairgrounds and Shopping malls are usually wide open areas. The construction is usually made from metal or concrete at the outside, which is positive due to less interference from outdoor cells. The inner area is made by a few dry or sheetrock walls.



### 3.2.4 Number of Users

One CDMA channel can handle up to 56 users at the same time. A ClearFill®Star BSI supports the capacity of 1 CDMA carrier. If more capacity is required, additional CDMA carriers can be designed to overcome capacity limitations.

	<p>Fairgrounds, theatres, stadium areas, meeting rooms and campuses are areas that might require capacity extension.</p> <p>Capacity planning has to be discussed with the network operator, responsible in general for the Base Transceiver Station.</p>
---	---

**1<sup>st</sup> step: Estimate number of subscribers**

**2<sup>nd</sup> step: Determine Erlangs usage**

- In-building clients > 25 mE/sub average

**3<sup>rd</sup> step: Decide quality of service (QoS)**

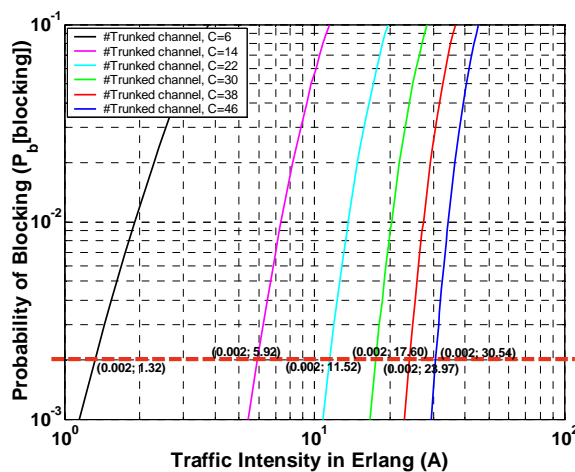
- 2% blocking high
- Recommended 0.2 % blocking

Erlang B table should be used to verify the required number of channels. The result may necessitate more than 1 RF source.

### Erlang B formula

$$P_b[blocking] = \frac{A^C / C!}{\sum_{k=0}^C \frac{A^k}{k!}}$$

**Figure 13 Erlang B formula**



**Figure 14 Traffic Intensity**

### 3.2.5 Typical parameters

Typical parameters for the system design are:

Required signal strength level for CPICH:	-80dBm...-85dBm
Required signal strength level for CPICH: (Strong outdoor signal present)	-70dBm...-75dBm
Reception probability (typical):	90%..95%
Coverage area for 1 RRH (typical):	2,500 sqm (25,000 sqft)
Typical propagation loss for antenna radius 28m (92 ft): (Office area with sheetrock walls)	-81 dB

### 3.3 Design step by step

This chapter explains the steps for designing a ClearFill®Star system. The assumptions and parameters for the design are explained in section 3.2.

#### 3.3.1 Determine coverage area per RRH

A ClearFill®Star RRH for CDMA with a CPICH output power of +4dBm (+14dBm carrier output power) can cover an area of 2500 sqm (25,000 sqft) under standard conditions.

Deviations from the standard conditions have an impact on the propagation loss:

- Additional wall loss or obstacles reduce the coverage area
- Less walls or less attenuation increase the coverage area.

#### 3.3.2 Number of RRH for Coverage 3G1x and EV-DO

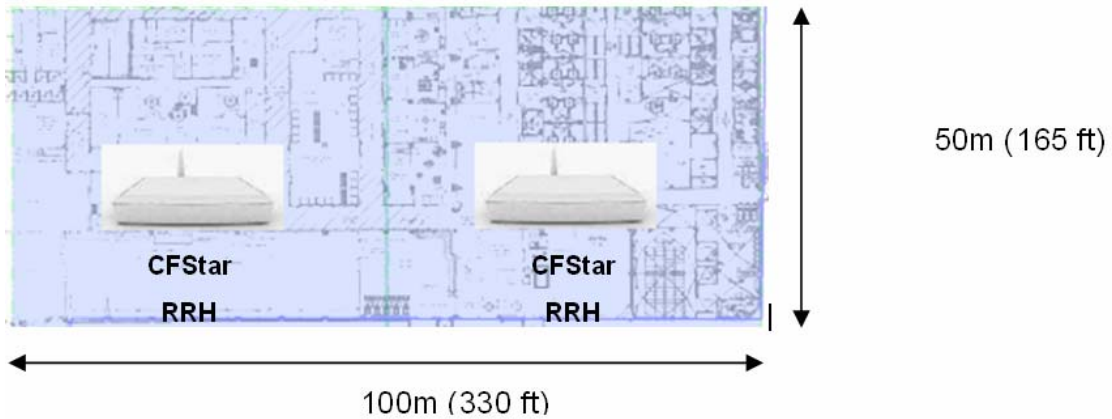
The maximum distance between RRH and mobile should not exceed 28m (92 ft) (for standard conditions).

It is possible to place several RRHs at the area to be covered by using RF-prediction software tools. The prediction software calculates and shows the estimated RF-coverage based on building and system parameters. The quality of the coverage prediction is highly dependant on the accuracy of the building parameters.

When designing a ClearFill®Star system without using a prediction tool, the first step should be to divide the area to be covered (e.g. complete floor or room) by the estimated coverage area of an RRH.

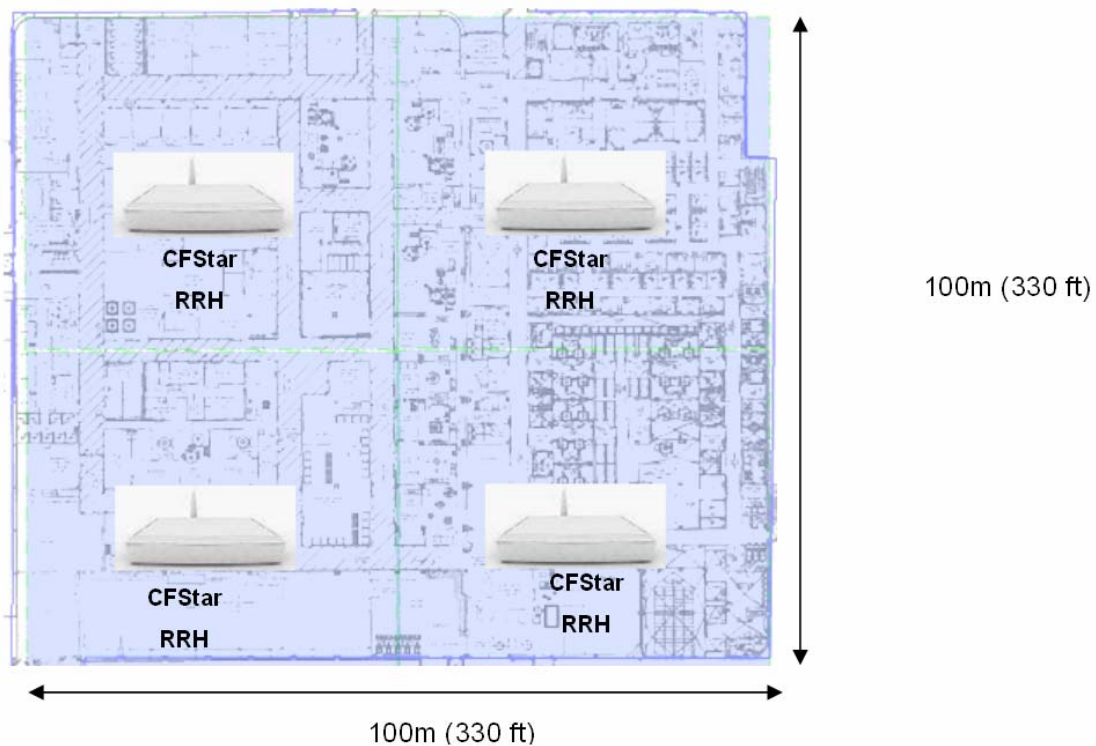
**Example 1:**

By using the standard propagation model, 2 Remote Radio Heads can cover a rectangular office floor with the dimensions 100m x 50m (330 ft x 165 ft).



**Example 2:**

For an office floor with the dimensions 100m x 100m (330ft x 330ft), 4 RRHs should be used.



Up to 24 RRHs can be connected to a summing GES. The number of RRHs is independent from the type of service (voice or data) for CDMA. At least 24 RRHs for voice 3G1x, 24 RRHs for data transmission EV-DO and the required number of RRHs for the guided hard-handover- service, called the beacon feature, can be connected to a summing GES.

For detailed information concerning summing modes please refer to section 3.5.

### 3.3.3 Number of RRH for beacon

ClearFill®Star system is capable to guide hard handovers from the outdoor macro carriers to the indoor carrier and vice versa reaching similar handover success rates as the soft handover in CDMA. The guided hard handover is supported by implementing a set of beacon RRHs at each entrance area.

A set of beacon RRHs consists of one RRH for the macro frequencies (installed inside the entrance) and one RRH for the indoor frequencies (located at the outside close to the door area).

Beacon RRHs can be connected without any impact on the maximum number of RRHs that can get connected to a summing switch.

RRH can generate up to 7 pilot beacon signals to support the hard handover. The beacon signals are generated alternatively to the mobile signal coverage function.

For further information, please refer to chapter 3.5.

### 3.3.4 Number of BSI

The BSI is the interface between BTS and Ethernet Infrastructure. Its function is in downlink to digitize and packet according to Ethernet standard the RF signal of the base station. For the uplink the BSI translates the digitized packet stream back to RF.

A summing function is included in the BSI, which sums the UL data streams of several RRHs.

The BSI is supporting voice or data service. A Twin-BSI can support 1 carrier voice and 1 carrier data or 2 carriers for each service (2 carriers for voice OR 2 carriers for data).

The number of BSIs depends on the capacity requirement; one single BSI can handle one carrier.

See Figure 15 and Figure 16 for typical BSI configurations.



### 3.3.4.1 Example 1 for Twin BSI configuration

1 carrier for data and 1 carrier for voice:

- 1 carrier CDMA 1900 3G1X  
AND
- 1 carrier CDMA 1900 EV-DO

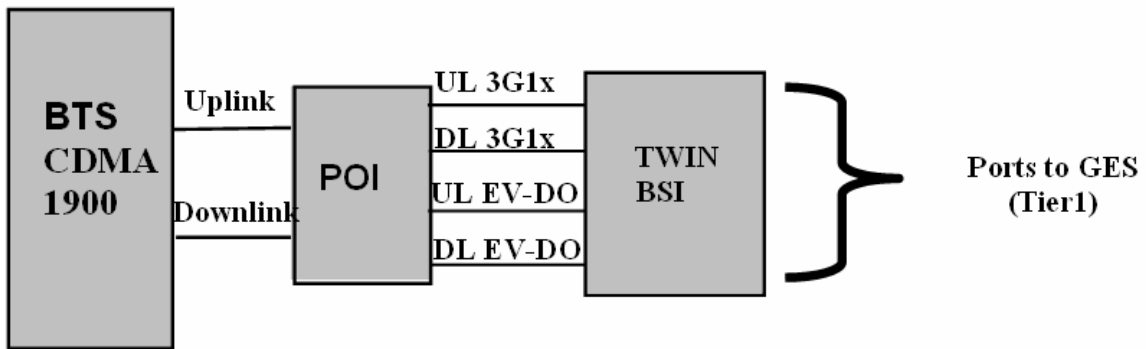


Figure 15 Example 1 for Twin-BSI configuration

Twin BSI configuration for 2 carriers/each service:

- 2 carriers CDMA 1900 3G1X  
OR
- 2 carriers CDMA 1900 EV-DO

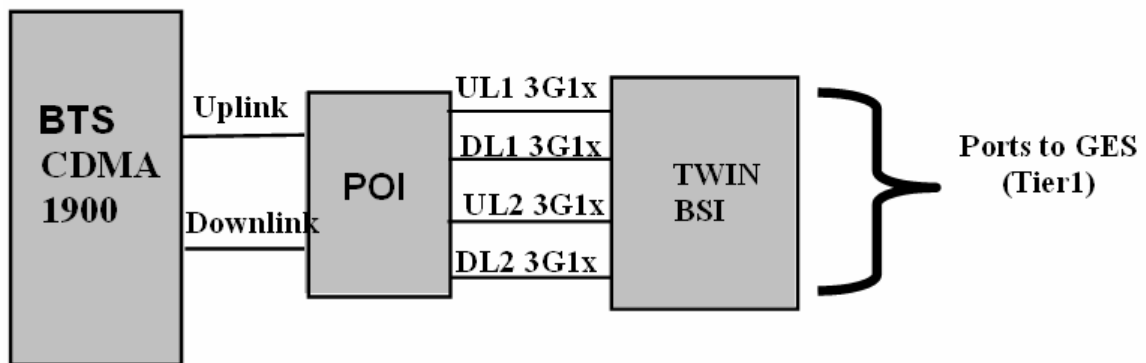


Figure 16 Example 2 for Twin-BSI configuration

### 3.3.5 Number of GES

The Gigabit Ethernet switch supports the functionality of the Remote Radio Heads and the NMS. All GES-settings are controlled and realized via NMS.

The GES provides Power over Ethernet (POE) to the RRHs and the BSI.

The GES can handle RRHs supporting voice, data and beacon service and BSI's.

Up to 12 Ethernet ports are available at the GES. Ports 11 and 12 can be used as optical ports, by using these ports only ports 1 to 10 can be used for an Ethernet based connection. The optical ports of the GES can be used to overcome the Ethernet based distance limitation of 100m (330ft) for cascaded Gigabit Ethernet switches (tier 2 level, ...) and/or the NMS.



**Figure 17 GES front view**

Ethernet ports 1-10 (RJ-45 type) are for connection of:

- 3G1x from/to BSI
- EVDO from/to BSI
- NMS
- RRHs for 3G1x
- RRHs for EVDO
- RRHs for Beacon

Ethernet ports 11 and 12 are meant to connect GES to:

- Tier 2/TierX Gigabit Ethernet Switches
- NMS

Optical ports (SFP type), can be used alternatively to Ethernet Port 11 and 12, for connection of:

- Gigabit Ethernet Switches
- NMS

The system structure for the GES and RRHs should be designed as a star hierarchy, so that each RRHs is connected to the main (Tier1) GES through the same number of GES.

Data, voice and beacon RRHs can be mixed at the cascaded GES. The last cascade needs one Ethernet port for the connection to the next GES (in topology). This ensures that 11 Ethernet ports can be used for the RRHs. Up to 16 RRHs for each service (data or voice) can be connected to a single BSI.

The Tier1 or main GES will act as the central point for all switches and the NMS, it is called root switch.



The number of GES depends on the RRH quantity and can be affected by distance.

A good design is to place a GES in a central location within a group of RRHs (up to 11 RRHs, because one port is needed for the connection to the next GES).

This minimizes the distance to each RRH. It is essential that the Ethernet cable length of 100m (330ft) is not exceeded.

#### **RRH Summing for Uplink:**

A summing function is included in the RRH, it sums the UL data streams for data or voice of up to 8 RRHs of the same GES. Beacon RRHs are not affected.

When all GES ports are connected with the maximum number of RRHs for a service, the maximum number of summing RRHs for data or voice is 2.

A cascaded structure can support up to 8 summing RRHs per service or sector.

The next pages show examples for the system structure of GES and RRHs:



### 3.3.5.1 ClearFill®Star example configuration 1 for PCS1900:

- 1 Carrier 3G1x (Voice)
- 1 Carrier EV-DO (Data)
- 1 Entrance covered with Beacon feature
- Area to be covered (typical for office) 2,500sqm (25,000 sqft)

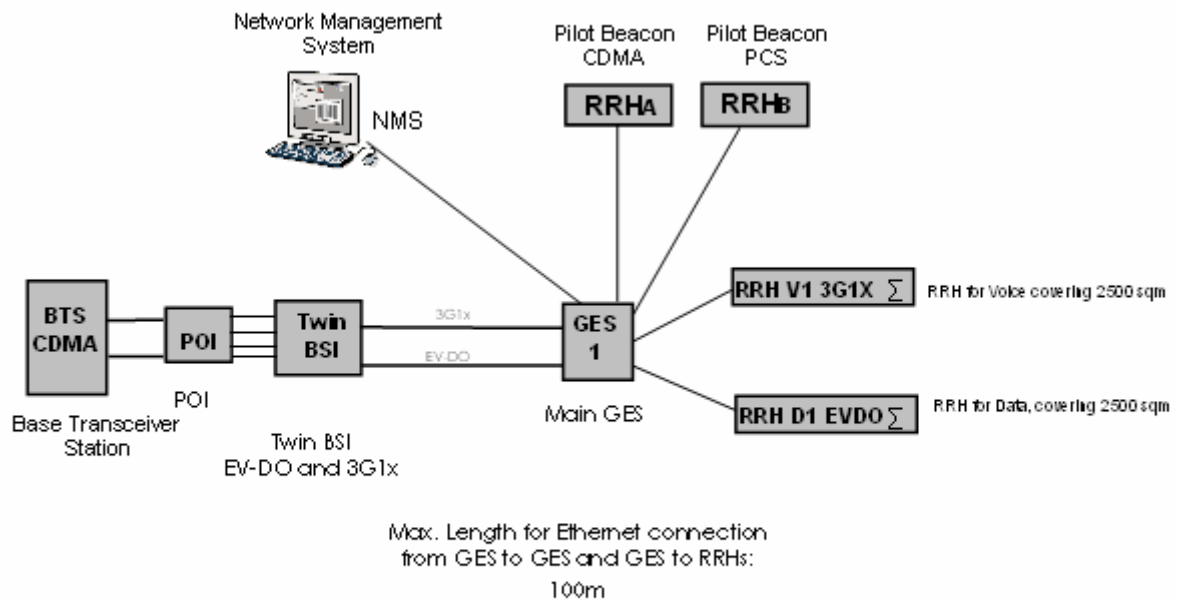


Figure 18 ClearFill®Star setup example 1

### 3.3.5.2 ClearFill®Star example configuration 2 for PCS1900

- 1 Carrier 3G1x (Voice)
- 1 Carrier EV-DO (Data)
- 1 Entrance covered with Beacon feature
- Area to be covered (office) 10,000sqm (100,000 sqft) (4 RRH with 2,500sqm/each)

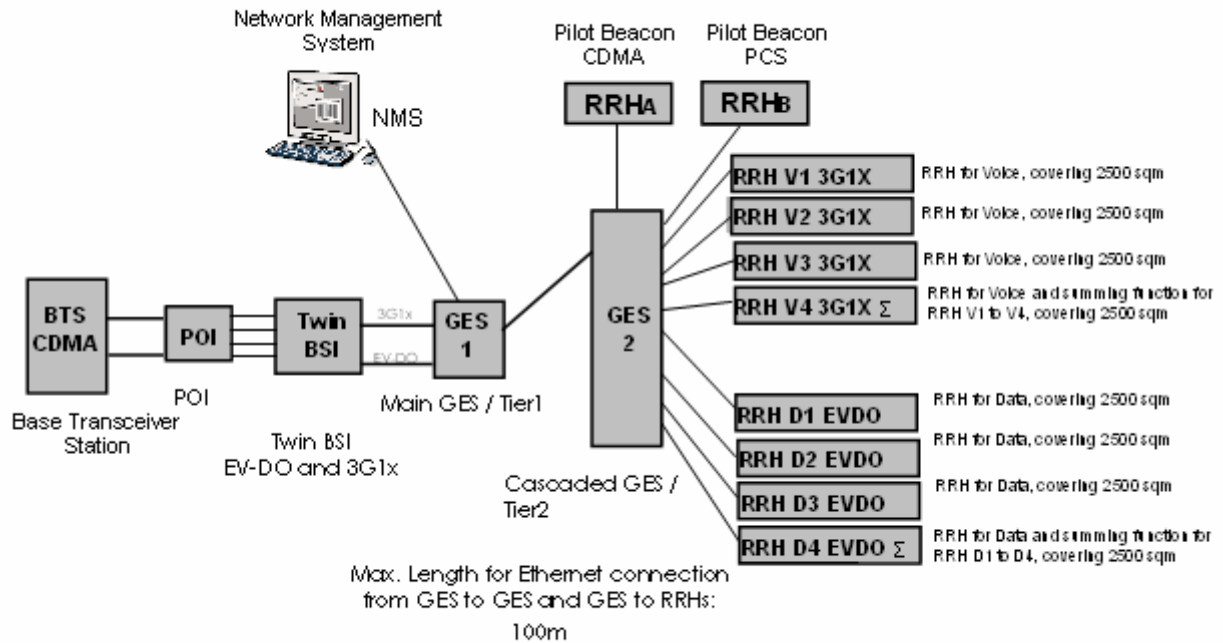


Figure 19 ClearFill®Star setup example 2

### 3.3.5.3 ClearFill®Star example configuration 3 PCS1900

- Max configuration for 1 GES
- 1 Carrier 3G1x (Voice)
- Area to be covered (typical for open office) 25,000sqm (250,000 sqft)
- (10 RRHs with 2,500sqm/each (25,000 sqft/each))

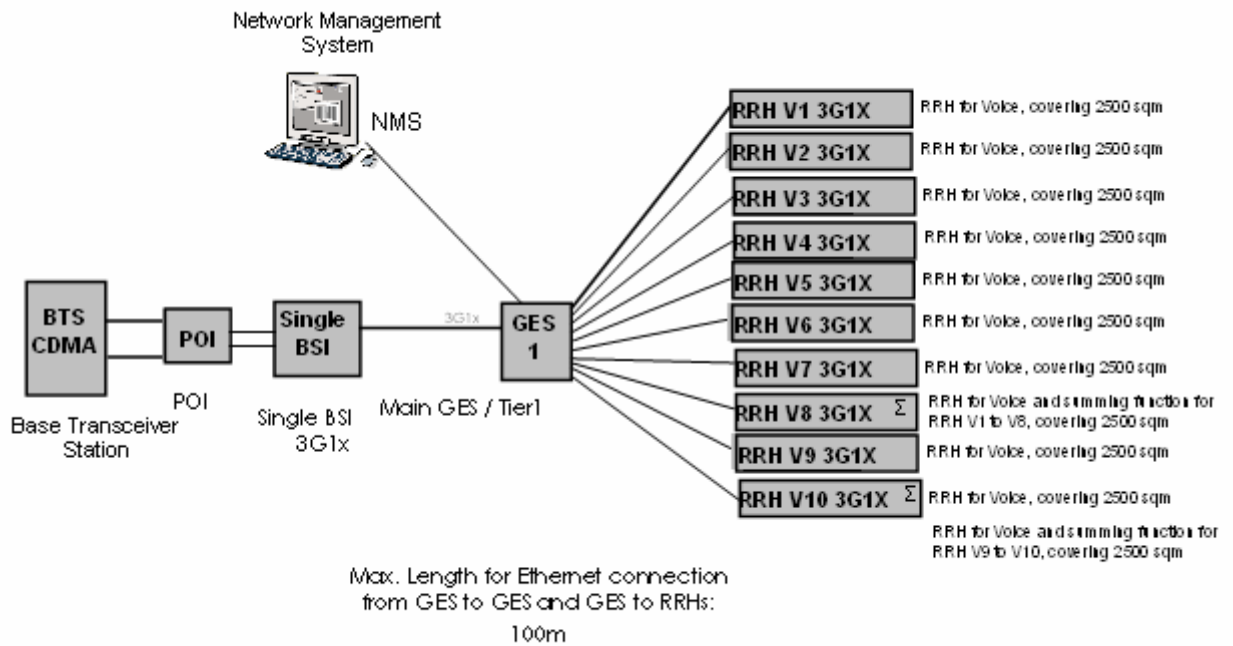


Figure 20 ClearFill®Star setup example 3

### 3.3.5.4 ClearFill®Star example configuration 4 for PCS1900

- 2 Carriers 3G1x (Voice)
- 2 Carriers EV-DO (Data)
- Area to be covered (typical for open office) 10,000sqm (100,000 sqft)
- Carrier allocation

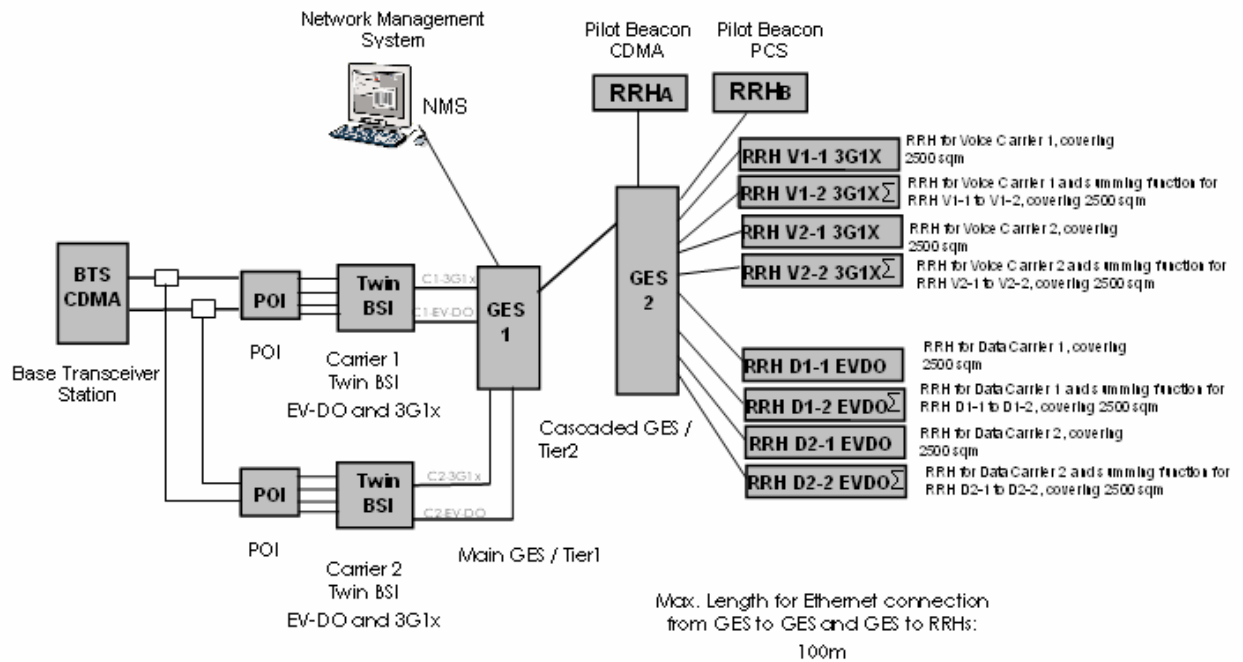


Figure 21 ClearFill®Star setup example 4



### 3.3.5.5 ClearFill®Star example configuration 5 for PCS1900

- 1 Carrier 3G1x (Voice)
- 1 Carrier EV-DO (Data)
- 2 Entrances covered by Beacon feature
- Area to be covered (typical for open office) 20,000sqm (200,000 sqft)
- (8 RRHs/each service with 2,500 sqm/each (25,000 sqft/each))

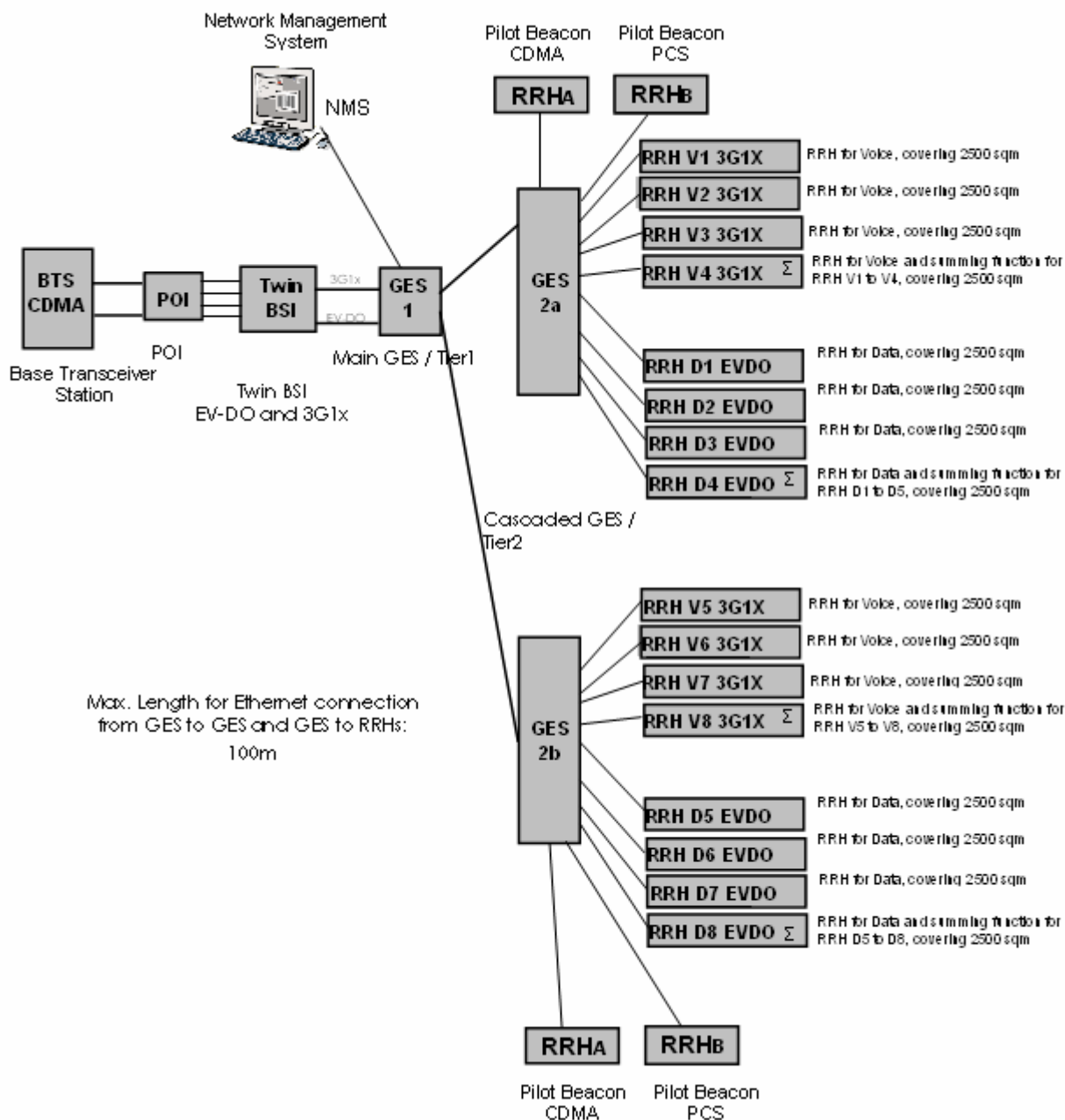


Figure 22 ClearFill®Star setup example 5



### 3.4 Estimated RF Coverage per RRH

#### 3.4.1 Propagation Model (Free Space Loss)

A simplified model is used to calculate the propagation losses for in- and outdoor environments.

Free-space propagation conditions are assumed. Obstacles penetrated in direction of transmission are causing additional RF losses.

Due to relatively short ranges in buildings, line-of-sight conditions can be assumed which are interrupted by obstacles. Consequently, impact of scattering is neglected. That leads to a fading model in which the logarithmic normal portion is only to representing shadowing effects. The Raleigh fading for non-line-of-sight conditions is deliberately ignored to simplify the model.

The propagation losses are calculated with the formula below:

$$\text{Losses [dB]} = 32.4 + 20 * \log_{10} (\text{Frequency [GHz]}) + \text{PC} * 10 * \log_{10} (\text{Distance[m]}) \\ + \text{Wall losses [dB]} + \text{fading margin [dB]}$$

PC: propagation coefficient

The propagation coefficient PC is dependant on the building itself and has to be adapted in order to meet the building topology. Estimates of PC are shown in Table 4.



Environment	Description	PC Low-Band < 1GHz	PC High-Band > 1GHz
Free Space	Corridor	2.0	2.0
Open: With very few RF obstacles	Parking Garage, Convention Center	3.37	3.01
Moderately Open: With low to medium amount of RF obstacles	Warehouse, Airport, Manufacturing	3.5	3.2
Mildly Dense: With medium to high amount of RF obstacles	Retail, Office Space with approx. 80% cubes and 20% hard-walled offices	3.61	3.31
Moderately Dense: With medium to high amount of RF obstacles	Office Space with approx. 50 % cubes and 50 % hard-walled offices	3.76	3.48
Dense: With high amount of RF obstacles	Hospital, Office Space with approx. 20% cubes and 80 % hard-walled offices	3.94	3.81

**Table 4 Examples for Propagation Coefficient (source: Wireless Valley)**

**3.4.1.1 Free Space Path Loss**

For free space propagation loss the formula defined in section 3.4.1 can be used. Wall losses can be removed from the formula and the propagation constant has to be chosen to be 2.

This model can be basically chosen for open indoor environments like rural areas.



### 3.4.1.2 In-Building Path Loss

For in-building applications, the PC has to be chosen correctly as already mentioned above. In addition to free space propagation, additional wall losses have to be introduced. Guidelines for different kind of wall types are presented in Table 5.

Attenuation / frequency ----- Costructional element	Attenuation @900 MHz	Attenuation @1850 MHz	Attenuation @2400 MHz	Attenuation @5000 MHz
Basement or foundation wall	13 dB	14 dB	15 dB	15 dB
Brick, concrete and concrete block	13 dB	14 dB	15 dB	15 dB
Cubicle wall	1 dB	1.5 dB	2 dB	2 dB
Drywall or sheetrock	2 dB	2.5 dB	3 dB	3 dB
Elevator or metallic obstacle	5 dB	8 dB	10 dB	10 dB
Glass door or window, no tint	2 dB	2.5 dB	3 dB	3 dB
Metallic rack	6 dB	6 dB	6 dB	6 dB
Wooden door	2 dB	2.5 dB	3 dB	3 dB

**Table 5 RF losses due to physical obstacles (Reference: Wireless Valley)**

### 3.4.2 Power Level Estimation (Link Budget)

This section describes the calculation of the expected UL and DL reception power levels. For this sample investigation a standard model of an area of 50 x 50 sqm (25,000 sqft) (resulting in a coverage radius of 34m (110 ft)) has been chosen to provide coverage and capacity for.

The model to calculate the propagation losses in indoor environments is described in section 3.4.1. In areas blocked by walls the simplified model is extended for non-line-of-sight conditions that cause Rayleigh fading. These conditions request an extended margin of 11dB. The propagation model assumptions are summarized in Table 6 Propagation Parameters

	Cell	PCS
Propagation	Free space	Free space
Wall loss	13	14
Fading loss (NLOS)	11	11
Fading loss (LOS)	6	6

**Table 6 Propagation Parameters**

### 3.4.2.1 Downlink

A coverage radius of a RRH in DL is calculated to be 28 m assuming 14 dBm composite output power of the RRH, a composite reception level of -85 dBm at 95 % reception probability at the handheld and the above given propagation model.

RRH Output Power Level	14.0 dBm
CPICH Power Level	7.0 dBm
RRH Antenna Gain	0.0 dBm
CPICH EIRP	0.0 dBm

Frequency	1950.00 MHz	
	min. Distance	max Distance
RRH Antenna Height	3.50 m	
Fading Margin	2.00 dB	6.00 dB
Body Loss	3.00 dB	
Slope Factor	2.00	2.20
Wall Loss	0,00 dB	13.00 dB
Mobile Antenna Gain	0.00 dB	
Mobile Antenna Height	1.50 m	
Nominal Reception Power Level (CPICH)	---	-85.00 dBm

Reception Power Level / min. Distance	-42.26 dBm
Max. Distance	27.77
Coverage area per antenna	2422.14 m <sup>2</sup>
Path Loss	92.00 dB

**Table 7 Downlink Parameters**

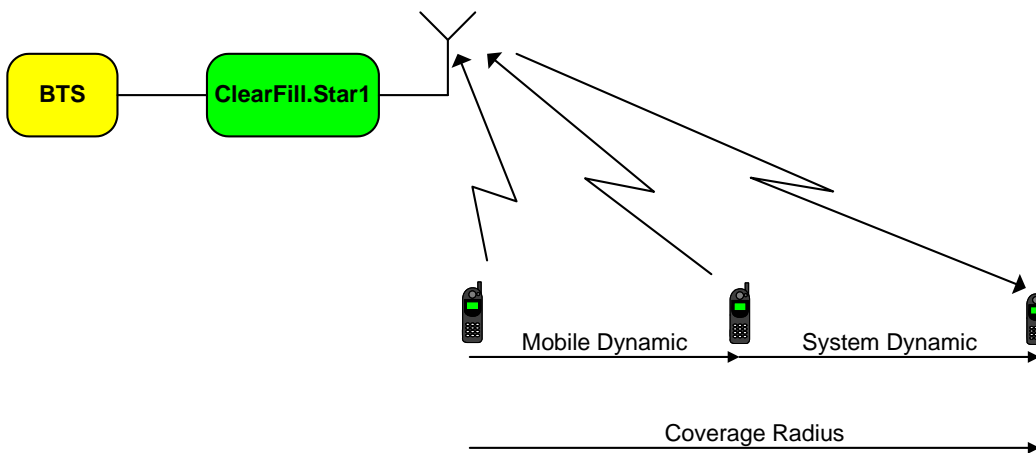
### 3.4.2.2 Uplink

For the mobile, the output power and dynamic range was assumed as shown in Table 8.

	Cell	GSM-850	PCS	GSM-1900
Maximum mobile output power	27 dBm	33 dBm	23 dBm	30 dBm
Minimum mobile output power	-50 dBm	5 dBm	-50 dBm	0 dBm
Mobile Antenna loss	-6 dBi	-6 dBi	-6 dBi	-6 dBi
Body loss	2 dB	2 dB	2 dB	2 dB
Mobile dynamic	77 dB	28 dBm	73 dB	30 dB

**Table 8 Power levels of mobiles**

The schematic scenario for calculation of the UL dynamic range is illustrated in Figure 23 Scenario for UL reception power level calculation



**Figure 23 Scenario for UL reception power level calculation**

The calculation result for the UL reception power levels is summarized in Table 9.

	Cell		PCS	
Distance handheld RRH	2.5 m	34 m	2.5 m	34 m
Reception level with max power at handheld	-18dBm	-67dBm	-29dBm	-79dBm
Reception level with min power at handheld	-95dBm	-144dBm	-102dBm	-152dBm

	GSM-850			GSM-1900	
Distance handheld RRH	2.5 m	6.5 m	34 m	2.5 m	34 m
Reception level with max power at handheld	-12 dBm	-20 dBm	-61 dBm	-22 dBm	-72 dBm
Reception level with min power at handheld	-40 dBm	-48 dBm	-89 dBm	-52 dBm	-102 dBm

**Table 9 Reception power levels for ClearFill®Star-CDMA**

6.5m correspond to a distance at which a GSM mobile produce an input power level of – 20dBm to the system (when transmitting at maximum power level). For this calculated distance no fading effects and wall losses have been considered.

In CDMA systems all mobiles are controlled via BTS to generate the same power level at the BTS in UL. Assuming a mobile at maximum coverage radius, the maximum expected input power level ClearFill®Star system is –67 dBm for CELL and –79 dBm for PCS under listed conditions of Table 6 Propagation Parameters and Table 9.

Full data rates in UL are requested at Rx levels of –67 dBm for CELL and –79 dBm for PCS.

### 3.4.2.3 Noise

The absolute minimum UL input power level is defined by the sensitivity of the system. Assuming a channel bandwidth of 1.25MHz, a noise figure of 12 dB and a min. required signal to noise ratio of 13.5 dB, the sensitivity of the system is calculated to be –87.,5 dBm. This represents the minimum input power level that can be transmitted by ClearFill®Star system (supporting SNR of 13.5dB) and that can be processed by a BTS.

### 3.4.3 Link Loss (Coverage distance)

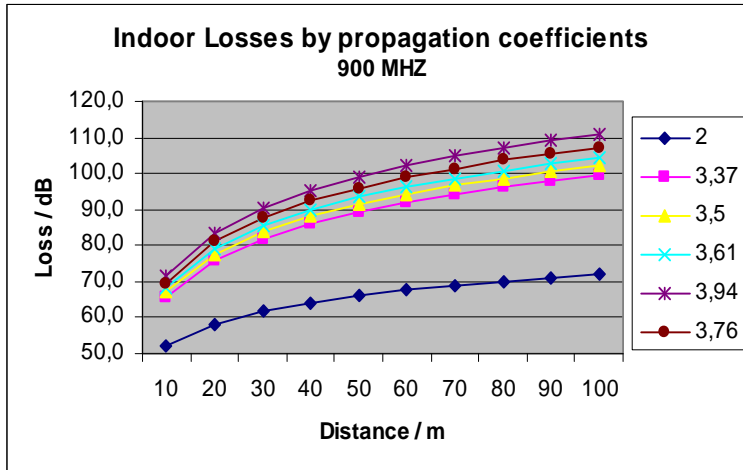


Figure 24 Indoor Loss for Different Building Types at 900 MHz

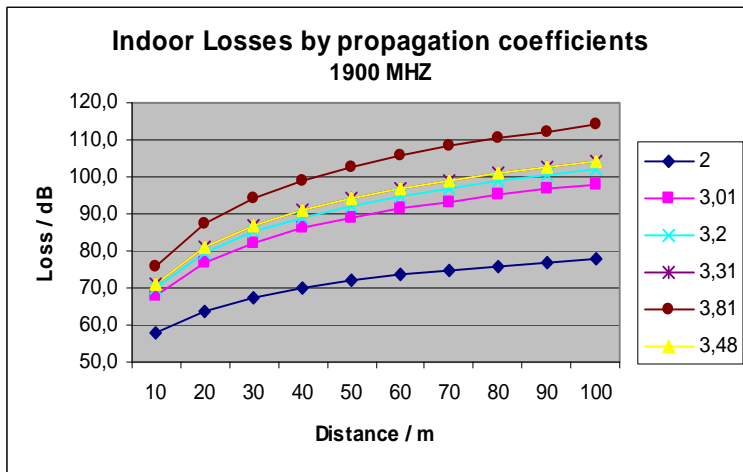


Figure 25 Indoor Loss for Different Building Types at 1900 MHz

3.4.4 Only one direct connected antenna (in preparation)

3.4.5 Examples of Coverage Estimates (in preparation)

3.5 Right-sizing - the beacon feature (in preparation)

3.6 Capacity demand - number for BSIs (in preparation)



## 3.7 System Architecture

### 3.7.1 Rules from the Ethernet World

#### 3.7.1.1 CAT5 lengths

Maximum CAT5 (or higher) cable length is 100 m (300 ft).

#### 3.7.1.2 Optical lengths

Maximum length of the multi mode fibers is 550 m (1650 ft)

#### 3.7.1.3 Cascade

Rules:

- Up to 4 Levels, including the main switch connected to the BSI.
- It is mandatory that all RRHs have same number of switches on the signal path to the BSI. This is applicable for each VLAN.
- Per switch a RRH is automatically assigned for the summing of up to 8 RRHs.
- The maximum number of RRH (summing or not), connected to one GES is limited to 8. For higher numbers, PoE limitations may apply.
- The total number of RRH per BSI is limited to 16.

### 3.7.2 Gigabit Ethernet Switch

#### 3.7.2.1 Layer

Layer 2 in the physical layer model

#### 3.7.2.2 Cascade

Rules:

- Up to 4 Levels, including the main switch connected to the BSI.
- It is mandatory that all RRHs have same number of switches on the signal path to the BSI. This is applicable for each VLAN.
- Per switch a RRH is assigned for the summing of up to 8 RRHs. In case more than 8 are connected to an individual switch there will be 2 RRHs dedicated for the summing.
- This should be avoided for the time being. Typical use case is 2 VLANs on the switch (not more than 8 RRHs per VLAN per Switch).
- The maximum number of RRH (summing or not), connected to one BSI is limited to 8.

### 3.7.3 Example system architecture

#### 3.7.4 System feeding

Adding Capacity by Growing Sectors on In-Building Solutions with ClearFill@Star: Unlike in the Macro Network, it is recommended that capacity be grown by adding sectors to the in-building system. The reason for this is increasing the number of sectors improves the ability to locate users within a building. Also, adding sectors to a ClearFill@Star System is less expensive than adding carriers.

Identifying the position of a user in a building is done by determining which base station sector is serving them. So by adding sectors, you are able to more accurately determine where a user is within a building or campus.

Each Base Station Interface (BSI) handles one sector and one carrier. Each Remote Radio Head (RRH) handles one sector and one carrier. Each Point of Intercept (POI) handles a carrier. Obviously to add either a carrier or a sector the base station needs additional equipment. The base station for ClearFill@Star doesn't need amplifiers or filters, but still has MCR (Radio) and URC (Radio Controller) and CMU (Channel Elements).

If a sector is added to increase capacity, then while a POI is not needed, a BSI, MCR and CMU is needed. If a carrier is added to increase capacity, an MCR is not needed, but a POI, BSI and CMU is needed. So the difference between adding a sector rather than adding a carrier is the need for a MCR (when adding a sector) versus the need for a POI (when adding a carrier). The additional sectors help to pinpoint end user location within the building. The need for a URC depends on the base station's total number of carriers. A URC does not need to be added when a sector is added.

A benefit of ClearFill@Star lies in its ability to use software to define the building or campus area covered by a sector, or by a carrier. The CFS Network Management System can change, via its GUI, which sector is radiated by any of the RRHs and/or what carrier is radiated.

So as capacity needs change within the building or campus, the coverage footprint of individual sectors or individual carriers may be modified.

##### 3.7.4.1 POI

RFS offers RF Point-of-Interconnect devices (POIs) to ease the RF connectivity (splitting / combining / RF leveling) between BSI and BTS.

The POI allows RF leveling by manually switchable attenuators to set:

- Nominal RF input power (downlink, forward) into the BSI (-57dBm)
- The signal into the BTS (uplink, reverse)

For example: The POI RFS CFS-POI-S1S2-819 (19" rack mount passive device) accepts a simplex (forward, reverse separate connectors) 850 or 1900 band signal and splits it into two simplex signals to connect with two BSIs (so-called twin BSI 19" rack). The 1900 MHz version RFS CFS-POI-S1S2-19 accepts a simplex (forward, reverse separate

connectors), 1900 MHz band signal and splits it into two simplexed signals to connect to two BSIs.

Each BSI has simplexed (forward, reverse separate) RF connectivity (two connectors per band class). Each BSI is a single carrier device (by configuration) but is capable to accept a multiple RF carrier signal: The BSI discerns (by configuration) the specific RF carrier which it shall convert to Ethernet. If two in-band (e.g. 1900) carriers are present (typically 1x EV-DO, 1x voice indoors), two BSIs (one twin BSI with 2 independent BSIs) are needed.

For CDMA, there is only one type of (RF dualband) BSI which can handle either, 850 or PCS signals. The BSI has two pairs of (simplex) connectors per band class (850 and 1900). The system configuration (via CFS NMS) will set each BSI, making it operate either in 850 or 1900, and either 3G-1X or EVDO.

RF levels at interface BTS and ClearFill®Star:

Downlink (BTS to POI):

POI Input Power 0 dBm +/- 6 dB

BSI Input Power is – 57 dBm

POI attenuator setting so that BSI level is kept

Uplink (POI to BTS):

BSI output noise – 38.5 dBm at max gain , -51.5 dBm at min gain.

BSI output power (carrier @ full loading and max. gain): -4 dBm

POI attenuator setting nominal 49, up to 63 dB in 1 dB steps.

BTS Input noise level is -87.5 to -101.5 dBm (at max. gain)

### 3.7.4.2 Caution - system delay

As every type of distributed system, ClearFill®Star introduces considerable system delays (latency) which need to be considered for proper setting of BTS parameters (e.g. search window).

Delay times are dependent from the specific system topology. Approximate values for system delay times are:

Downlink (BSI to RRH):

67.0 micro seconds (e.g. simple topology, 2 GES layers)

71.5 microseconds (e.g. typical topology, 3 GES layers)

75.0 microseconds (e.g. complex topology, 4 GES layers)

Uplink (RRH to BSI):

130 microseconds (e.g. simple topology, 2 GES layers)

131 microseconds (e.g. typical topology, 3 GES layers)

132 microseconds (e.g. complex topology, 4 GES layers)

## 4 System Installation

### 4.1 General

#### 4.1.1 Safety Considerations

PTFE and PTFE Composite Materials:

Materials should never be heated to the point where smoke or fumes are evolved.

Any person feeling drowsy after coming into contact with PTFE, especially dust or fumes should seek medical attention.

#### 4.1.2 Packing List

Each unit comes with a packing list. Please check the completeness of each unit and contact RFS directly to claim any missing parts.

Each unit comes with required installation material for normal installation. In case, special mounting places are foreseen (e.g. false ceilings or wooden walls), the special mounting accessory is not part of the RFS delivery and has to be provided locally.

It is absolutely essential to document the system topology and the system setup.

Please write down during the installation:

- MAC address of every RRH and BSI
- Connected ports of every GES and devices they are connected to
- Sector each installed device is meant to operate in

#### 4.1.3 Health and Safety Warnings

- The installation may only be carried out by qualified personnel that are familiar with the hazards involved and the relevant statutory regulations.
- Read and obey all warning labels attached to the unit and in the manuals. Make sure that the warning labels are kept in a legible condition and replace any missing or damaged labels.
- In the United States: Obey all Occupational Safety and Health Administration (OHSA) regulations relating to work on high voltage installations, as well as regulations covering correct use of tools and personal protective equipment. Outside the US, please observe the local legal instructions concerning Safety and Health.
- Keep user handbook within easy reach and make them available to all users.
- It is the responsibility of the network provider to implement prevention measures to avoid health hazards which may be associated to radiation from antennas connected to any unit.
- Use this equipment only for purpose specified by RFS. Do not carry out any modifications or fit any spare parts which are not sold or recommended by RFS. This could cause fires, electric shock, or other injuries.
- Make sure the network element settings are according to the intended use (see also product information of RFS) and regulatory requirements are met.



#### 4.1.4 Installation Locations and requirements

All RFS ClearFill®Star units are designed to be installed indoors.

The RFS ClearFill®Star equipment operates over CAT5, CAT-5E or CAT6 cable of type unshielded twisted pair (UTP), foiled twisted pair (FTP) or screened twisted pair (ScTP), with shielded RJ-45 connectors; or Single-mode fiber (SMF) or multi-mode fiber (MMF) cable with SC/APC fiber connectors throughout the fiber network, including fiber distribution panels.

All above named cables are widely used industry standards for Local Area Networks (LANs).

The regulations and guidelines for ClearFill®Star cable installation are identical to those specified by the TIA/EIA 568-A standard and the TIA/EIA/IS-729 supplement for LANs.

RFS recommends plenum-rated Cat-5E/6 ScTP and fiber cable and connectors for conformity to building codes and standards.

In order to meet FCC and CE Mark emissions requirements, the Cat-5E/6 cables must be screened (ScTP) and it must be grounded using shielded RJ-45 connectors at both ends.

#### 4.1.5 Recommended Tools/Installation Incidentals

- Cable ties
- Phillips screwdriver
- 7-inch lb. torch wrench
- Drill
- Fiber connector cleaning kit
- Fusion splicer
- Splicing tool kit (including: snips, cladding strippers, fiber cleaver, isopropyl alcohol, lint-free wipes)
- Fusion splicing sleeves
- Fiber cleaning supplies: compressed air, isopropyl alcohol, lint-free cloths 2.5mm lint-free, foam tipped swabs
- Compressed air

#### 4.1.6 Accessories to be provided locally

For NMS Server (CFS-NMS-1):

- Monitor (VGA)
- Keyboard (PS2 or USB)
- Mouse (PS2 or USB)
- power cord, if different from US
- For each GBit Ethernet Switch (CFS-GES-1):  
LAN cable to NMS  
LAN cable for each BS Interface:



## 4.2 System Installation (Hardware Installation)

The following has to be carefully observed during installation, because most of the following issues are the cause of malfunctions:

- Faulty cabling/connector
- Dirty connectors and ports
- Malfunction of one or more components
- Antenna, base station, or repeater problem
- External RF interface
- Tripped circuit breaker
- Equipment is not grounded



Faulty cabling is the cause of a majority of problems. All Cat-5E/6 cable should be tested to TIA/EIA 568-A specifications.

### 4.3 Installation Radio Remote Head (RRH)

Before beginning the installation of the RRH, all RF cables (if applicable) and Ethernet cables should be installed.



Please follow the general procedure for installing the RRH as it is described below. It is important that the above installation instructions are followed in the sequence presented to ensure a correct and save installation.

1. Transport the RRH to the installation site in its packaging.
2. Remove the RRH from its packaging and check for obvious signs of physical damage. If unit is physically damaged do not proceed with the installation.
3. Check the packing for completeness according to the packing list.
4. Take the metallic holder for the RRH and use it as a template to mark the three drilling holes at the designated mounting place.
5. The provided dowels in the accessories kit are suitable for installation in indoor areas (closed spaces) only and for following wall constructions:
  - Concrete
  - Pre-stressed hollow-core concrete slabs
  - Natural stone with dense structure
  - Solid brick
  - Sand-lime solid brick
  - Solid block made from lightweight concrete
  - Air Crete
  - Solid panel made from gypsum
  - Hollow block made from lightweight concrete
  - Slabs made of perforated bricks
  - Hollow concrete blocks etc.

In case the provided dowels do not fit, special fixing material has to be used. It has to be ensured that the wall fixings are adequate for a total weight of more than 1.4 lbs (600 g).
6. Drill the holes to which the holder is to be fitted.
7. If the afore mentioned wall/roof construction is given, mount the holder with appropriate dowels/screws to its place and mount the RRH onto the holder by sliding it onto the holder. Check the firm fastening.
8. Connect the antenna or a DAS to the output port of the RRH. The connection cable between RRH and antenna has to be < 3 m (< 10 ft). The orientation of the antenna shall be vertical.
9. To complete the installation, connect the LAN cable to the RJ45-port of the RRH.
10. For rack-mount or desk-mount installations of the RRH, use the self-adhesive rubber bumpers.

#### 4.4 Installation Gigabit Ethernet Switch (GES)

GES is designed to be mounted into a 19" rack. Remove the GES from its packaging and check for obvious signs of physical damage. If the unit is physically damaged do not proceed with the installation. Check the packing for completeness according to the packing list.

To mount the GES to a rack, the angles that are delivered with the accessory kit have to be fixed to the housing. Voltage of mains must 115/230 VAC  $\pm$  10%. Connect the mains cord (from the accessory kit) to the rear connector of the GES and install the GES at its designated place within the rack.

##### Interconnection of the GESs

Use IP ports 11 and 12 to connect the GES with other GESs. Port 11 and 12 are identical to SFP ports 1 and 2. Use either IP port 11 OR SFP port 1. Use either IP port 12 OR SFP port 2.

After the physical setup has been performed and the BSIs and RRHs have been connected to the GES, the IP setup can be done. This is described in section 4.7.3.

#### 4.5 Installation Base Station Interface (BSI)

BSI is designed to be mounted into a 19" rack. Remove the BSI from its packaging and check for obvious signs of physical damage. If the unit is physically damaged do not proceed with the installation. Check the packing to completeness according to the packing list. The BSI is ready to be installed directly at its designated place into the rack using the accessories from the accessory kit. The BSI is power supplied via Ethernet (PoE), but there is also an external power supply available, input voltage 90 – 264 VAC, output voltage 48VDC.

#### 4.6 Installation NMS Server (Hardware)

Remove Network Management System Server for ClearFill®Star (CFS-NMS-1) from its packaging and check for obvious signs of physical damage. If the unit is physically damaged do not proceed with the installation. Check the packing to completeness according to the packing list.

Install the NMS Server into a 19" rack. Connect a monitor, a keyboard, and a mouse (to be provided locally) to the server using the appropriate interfaces on the front side.

Voltage of mains must be 115/230 VAC  $\pm$  10%. Connect the server at the rear side to mains (cable to be provided locally).

Connect the server via its LAN connector (RJ45 on the front side) to the GBit Ethernet Switch (CFS-GES-1) with a LAN cable (to be provided locally).

The CFS-NMS-1 installation is completed now.



## 4.7 Commissioning of NMS

After all steps above have been done the NMS server can be started. The elements of the system should be started (supplied with power) in this sequence:

- NMS server
- Root Switches (+BSI)
- Access Switches (RRHs are also started due to PoE)

### 4.7.1 Start of NMS Server

1. Press left most red button on front panel of NMS server until the fan power led starts to glow (green led).
2. The windows operating system starts. The NMS server application and all necessary services are started automatically in the background. This is done even before user login. The server is operational now. Login is done in this chapter only to check if all devices have been discovered correctly by NMS, usually the user login is only necessary to change system settings.
3. This first run is only meant to check if all devices have been found.
4. The operating system prompts for a password.  
Default password is: **nmsadmin**.

### 4.7.2 BTS – ClearFill®Star Integration

Refer to Section System Design, subsection POI, for appropriate RF levels and system delay times.

### 4.7.3 Commissioning of ClearFill®Star via NMS



This chapter describes only how to use the NMS server to check if all devices have been connected correctly. The NMS server and the client application and the correct setup are described in later chapters.

### 4.7.3.1 IP Address Configuration

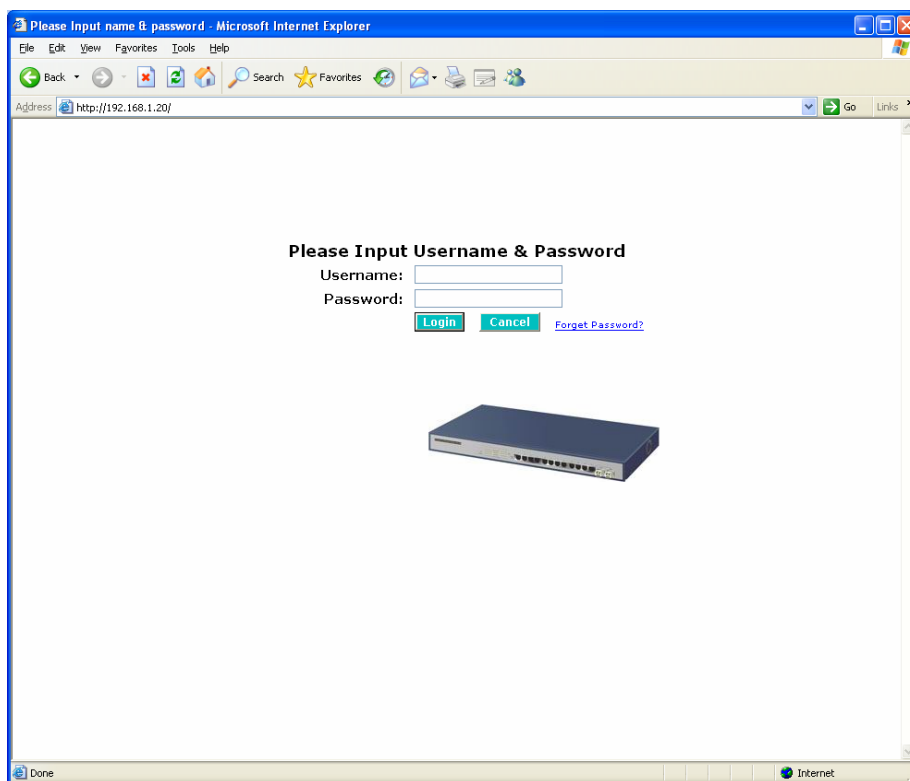
First of all the IP configuration has to be done for the whole network. The GES are set to fixed IP addresses, the BSIs and RRHs are using dynamic IP addresses. The NMS server is running a DHCP server to provide the dynamic IP participants with IP addresses.

All GES are delivered with the same default IP address: 192.168.1.1. Because of that the GESs have to be switched on one after another. Every time a new switch has been switched on it has to get assigned a unique fixed IP address. RFS recommends using switch addresses between 192.168.1.20 – 192.168.1.50, but users are free to choose the fixed addresses according to their specific setups.

Procedure to set a fixed address to a GES

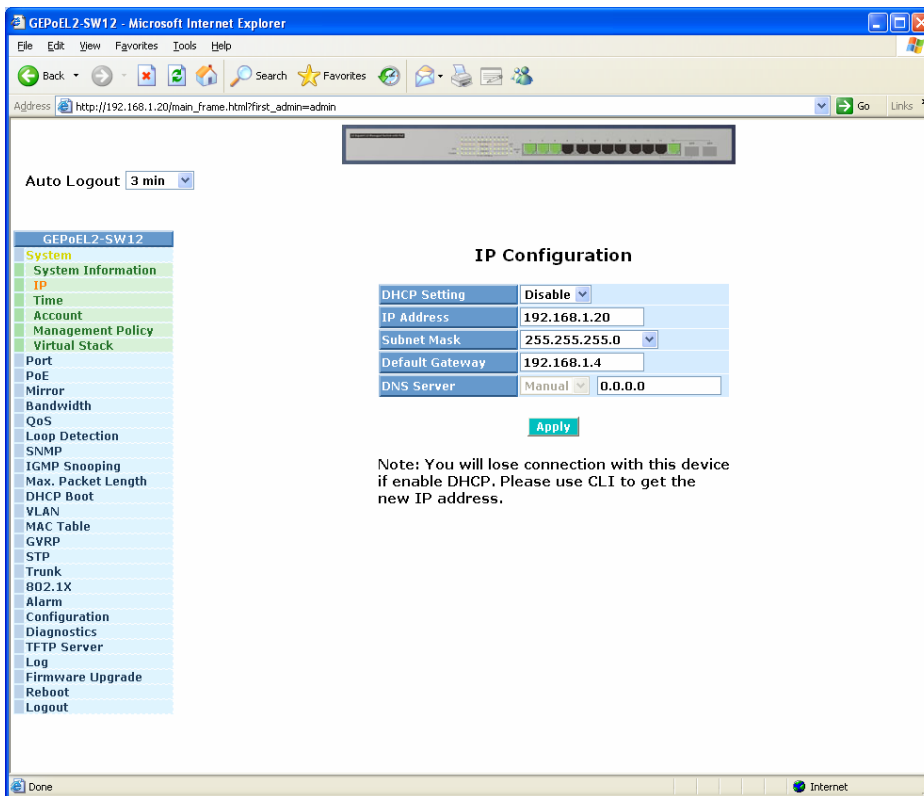
1. Open Microsoft Internet Explorer.
2. Enter the address "http://192.168.1.1" in the address window.
3. Login to the switch by using

Username: **admin**  
Password: **admin**



**Figure 26 GES Login Menu**

4. Click on System in the left-hand sides menu.
5. Click on IP in the opening sub menu.



**Figure 27 GES IP Configuration Menu**

6. Leave DHCP setting to "Disable" (by drop down menu).
7. set IP address to the desired value (unique IP address within the network).
8. Set Subnet Mask to: 255.255.255.0
9. Set Default Gateway to: 192.168.1.4 (default address of NMS server)
10. Leave DNS server to: 0.0.0.0
11. Click on Apply.
12. Click on Reboot in left hand side menu.
13. Click on "Save and Reboot" in the right hand side window.

Repeat this procedure with every GES in the network. Start with the switch that is closest to the BSIs (root switch) and follow the network topology to the GES that has the longest topological distance to the BSI (access switches).

After following this IP setup the GESs should have their own individual IP addresses.

#### 4.7.3.2 SNMP Configuration of GES

The Switches have to communicate via SNMP with the NMS server. This chapter shows how to setup a GES for SNMP support.

Procedure to set a GES to support SNMP:

1. Open Microsoft Internet Explorer.
2. Enter the address "http://192.168.1.1" in the address window.
3. Login to the switch by using  
Username: **admin**  
Password: **admin**
4. Click on SNMP in the left-hand sides menu. See Figure 28 for the SNMP menu that appears.
5. Set SNMP to: enable
6. Set Get Community to: public
7. Set Set Community to: private, Enable
8. Set Trap Host 1 IP Address to: 192.168.1.4; 162; public
9. Click on Apply .
10. Click on Reboot on the left hand side menu.
11. Click on "Save and Reboot" in the left hand side menu.

Repeat this procedure with every GES in the network. Start with the switch that is closest to the BSIs (root switch) and follow the network topology to the GES that has the longest topological distance to the BSI (access switches).

After following this procedure all GES are ready for SNMP usage.

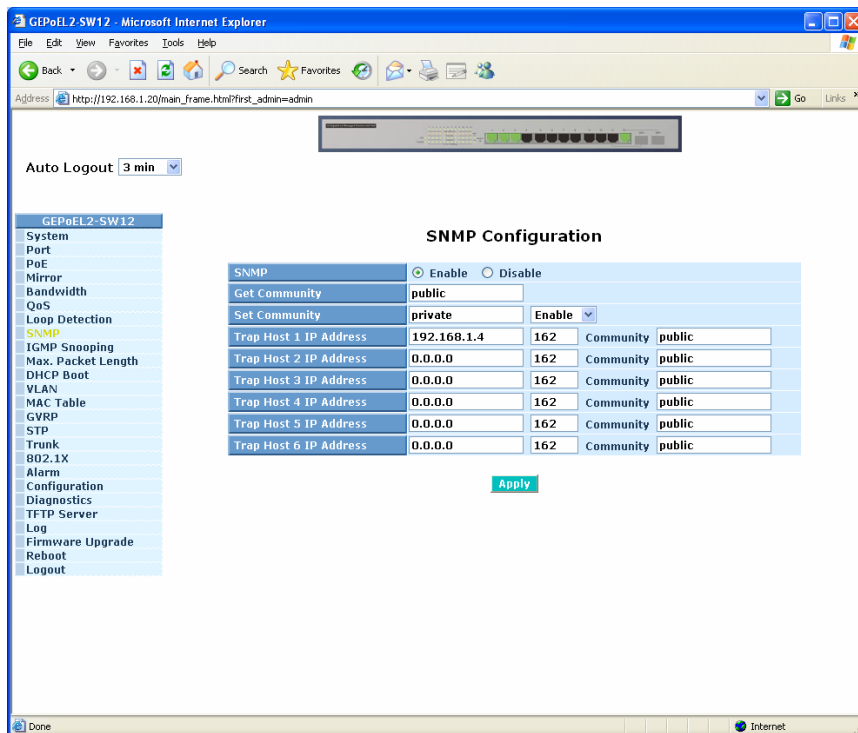


Figure 28 GES SNMP configuration menu

### 4.7.3.3 STP configuration of GES

The ClearFill®Star system uses the spanning tree protocol. It has to be activated in every GES. Procedure to set a GES to support STP:

1. Open Microsoft Internet Explorer.
2. Enter the address “http://192.168.1.1” in the address window.
3. Login to the switch by using  
Username: **admin**  
Password: **admin**
4. Click on STP in the left-hand sides menu.
5. Click on the appearing sub menu Configuration, see Figure 29 for the STP menu that appears.
6. Set “Spanning Tree Protocol” to: enable (via drop down menu).
7. Set Bridge Priority to:
  - a. 36864 for an access switch (switch that is not directly connected to a BSI)
  - b. 4096 for a root switch
8. Set Hello Time to: 1
9. Set Max.Age to: 6
10. Set Forward Delay to: 4
11. Set Force Version to: RSTP (via drop down menu)
12. Click on Apply.
13. Click on Reboot on the left hand side menu.
14. Click on “Save and Reboot” in the left hand side menu.

Repeat this procedure with every GES in the network. Start with the switch that is closest to the BSIs (root switch) and follow the network topology to the GES that has the longest topological distance to the BSI (access switches).

After following this procedure all GES are ready for STP usage.

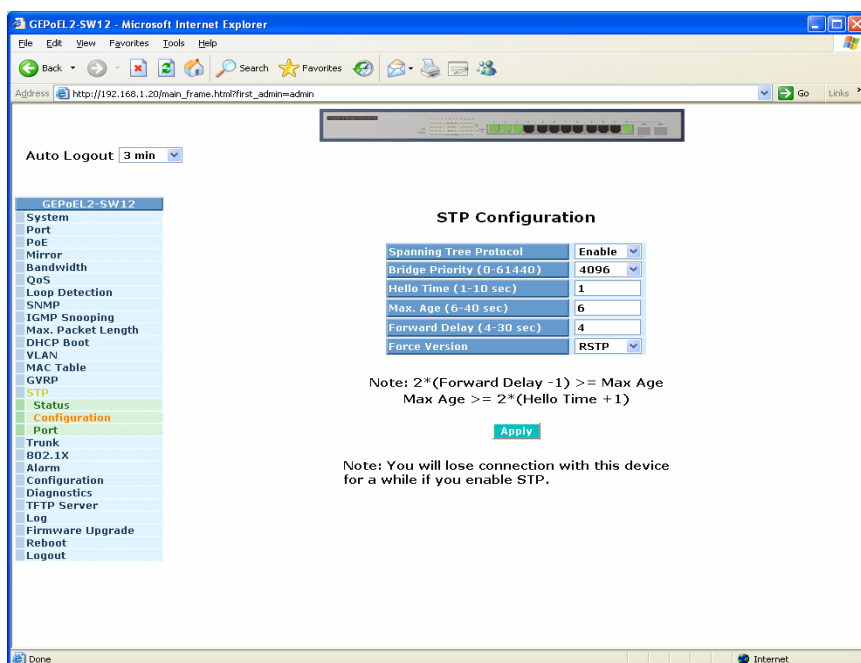


Figure 29 GES STP configuration menu

#### 4.7.3.4 VLAN Configuration of GES

The ClearFill®Star system uses the tag based VLAN mode. There are three different tags used in the ClearFill®Star network:

- NMS
- Voice
- Data

The three tags have to be configured in every GES. Also the support of every VLAN port has to be setup for every port of the GES.

Therefore it is mandatory that a good documentation of the installed hardware is available. It should have been created during the hardware installation process (see section 4.2).

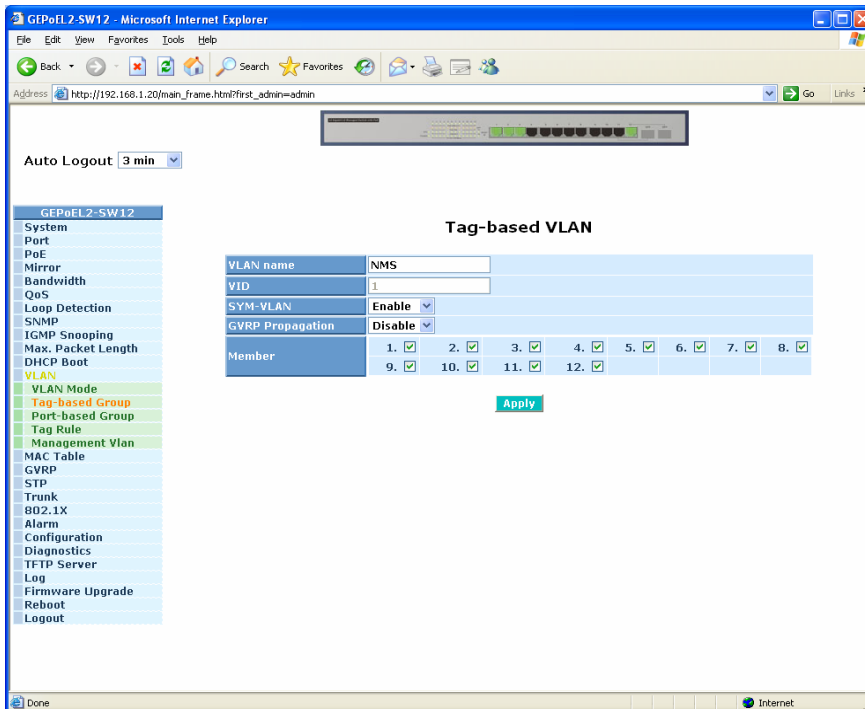
For every GES it has to be known

- Which ClearFill®Star network elements are connected to which port?
- Which sector are the network elements supposed to be operating in?

The VLAN tags are chosen to reflect the sector.

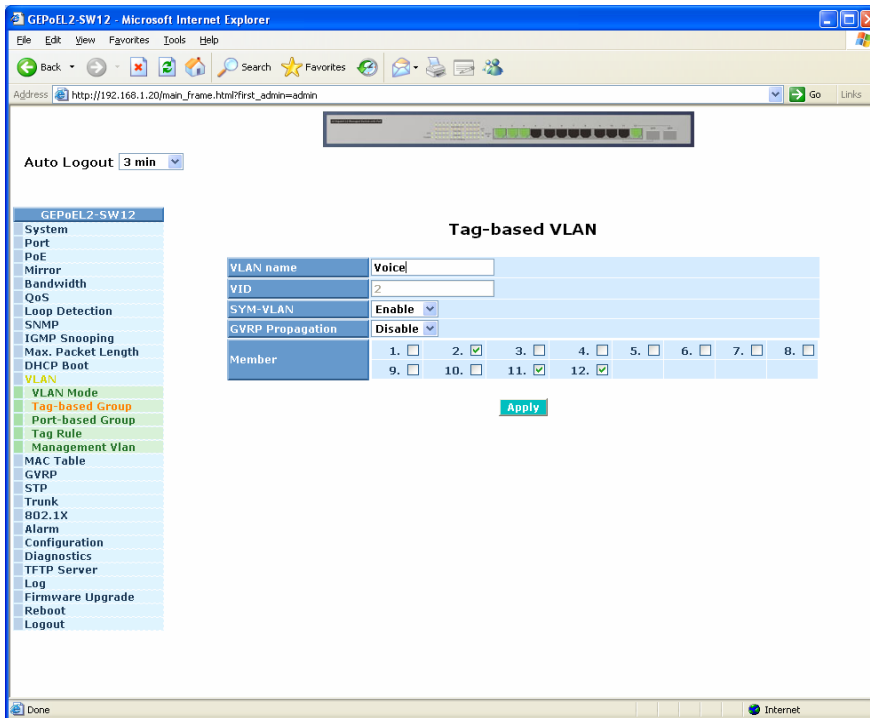
Procedure to set a GES to support STP:

1. Open Microsoft Internet Explorer.
2. Enter the address "http://192.168.1.1" in the address window.
3. Login to the switch by using  
Username: **admin**  
Password: **admin**
4. Click on VLAN in the left hand side menu.
5. Click on VLAN Mode in the appearing submenu.
6. Select Tag-Based in the upper drop down menu.
7. Click on Apply.
8. Click on Tag-based Group in the left hand side menu.
9. Select default: VLAN tag
10. Click on Edit.
11. Set VLAN Name to: NMS
12. Set VID to: 1
13. Set SYM-VLAN to: Enable (via drop down menu)
14. Set GVRP Propagation to: Disable (via drop down menu)
15. Activate: every port (1-12)
16. Click on Apply.



**Figure 30 GES tag based VLAN configuration menu for NMS**

17. Click on Add.
18. Set VLAN Name to: Voice
19. Set VID to: 2
20. Set SYM-VLAN to: Enable (via drop down menu)
21. Set GVRP Propagation to: Disable (via drop down menu)
22. Activate every port that is connected to a device that is going to operate within the voice sector and activate ports 11 and 12. The last two ports are needed to route the information through the cascaded GESs.
23. Click on Apply.



**Figure 31 GES tag based VLAN configuration menu for Voice**

24. Click on Add.
25. Set VLAN Name to: Data
26. Set VID to: 3
27. Set SYM-VLAN to: Enable (via drop down menu)
28. Set GVRP Propagation to: Disable (via drop down menu)
29. Activate every port that is connected to a device that is going to operate within the data sector and activate ports 11 and 12. The last two ports are needed to route the information through the cascaded GESs.
30. Click on Apply.



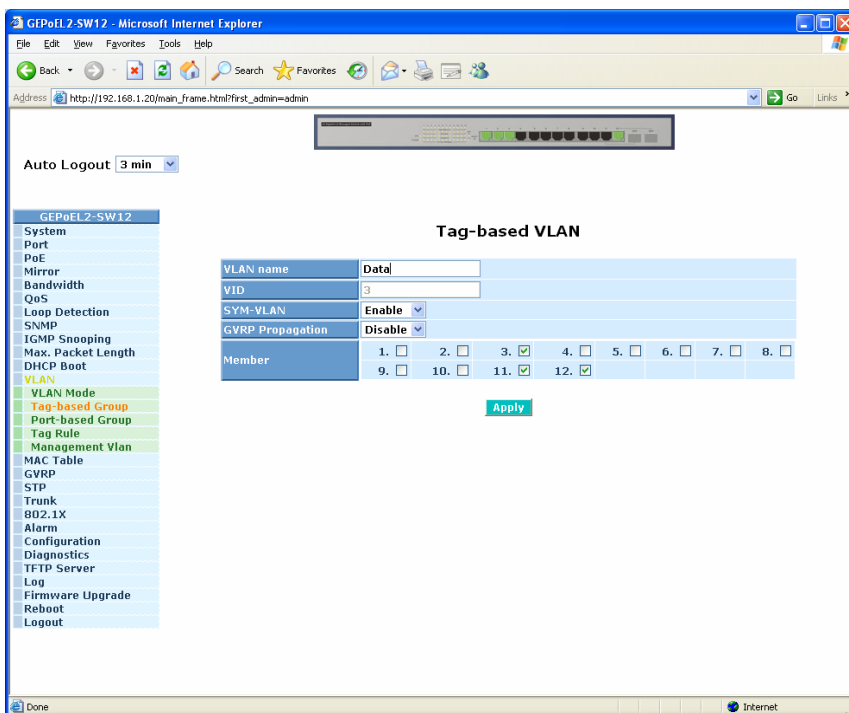


Figure 32 GES tag based VLAN configuration menu for Data

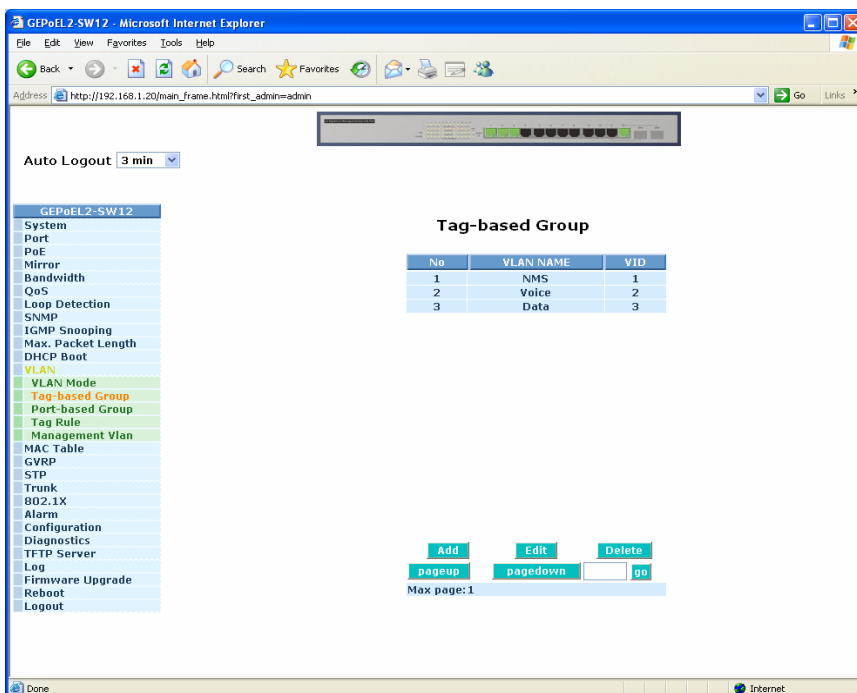


Figure 33 GES tag based VLAN configuration menu

31. Click on VLAN on the left hand side menu
32. Click on the sub menu Tag Rule

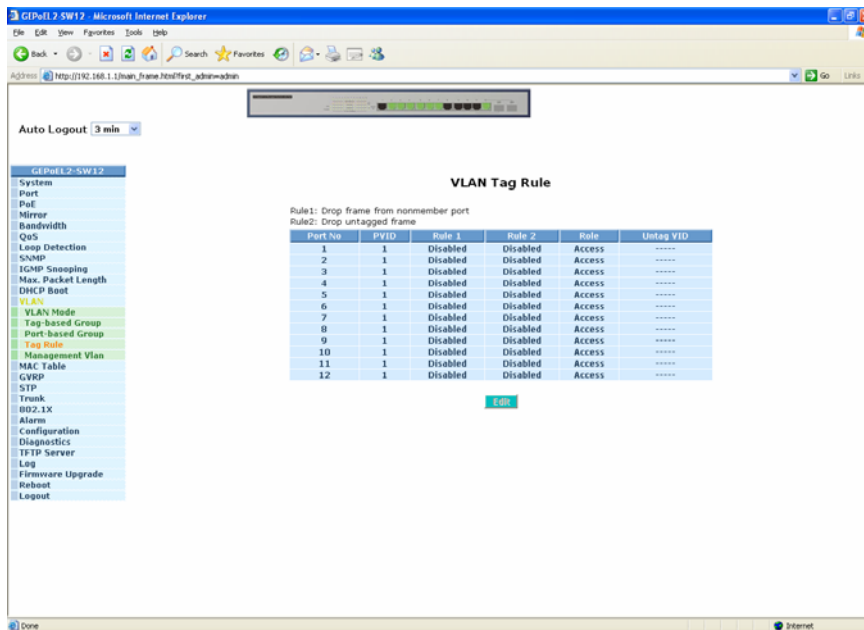


Figure 34 GES VLAN Tag Rule menu

33. Configure each port for of the GES according to its specific use.

34. Mark each port by clicking on the appropriate line and than click on Edit.

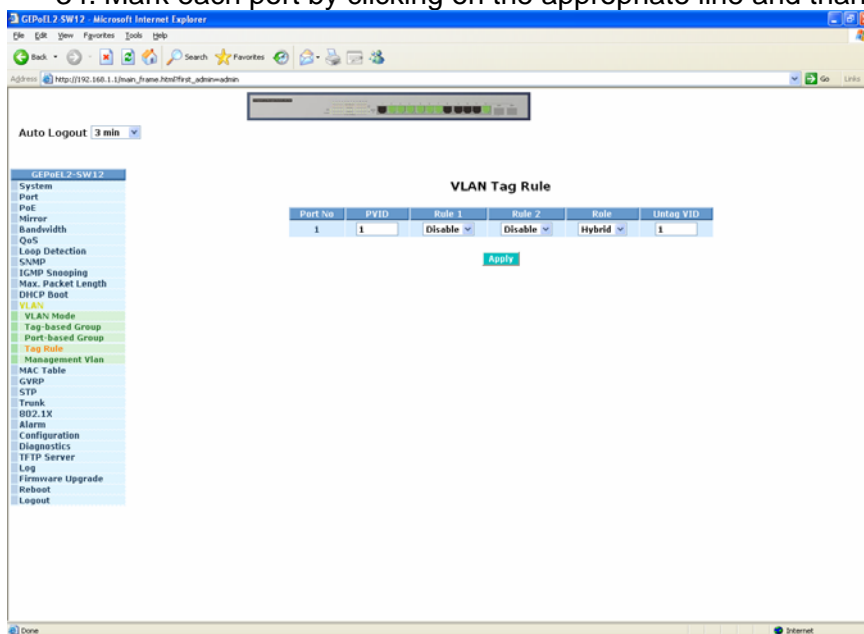


Figure 35 VLAN Tag Rule Edit Menu

35. Afterwards set the Role drop down menu according to the use of the port:

- Ports that are used for the connection of an RRH or a BSI are set to “Hybrid”.
- Ports that are used to connect the NMS/PC are set to: “Access”.
- Ports that are used for the interconnection of GES are set to: “Trunk”.

36. All other fields are set to default values:

- a. PVID = "1"
- b. Rule 1 = "disable"
- c. Rule 2 = "disable"
- d. "Untag VID" = "1"

37. To finish and store the GES configuration click on Reboot on the left hand side menu.

38. Click on "Save and Reboot" in the left hand side menu.

Repeat this procedure with every GES in the network. Start with the switch that is closest to the BSIs (root switch) and follow the network topology to the GES that has the longest topological distance to the BSI (access switches).

After following this procedure all GES are ready for VLAN tag usage.

#### 4.7.3.5 Start NMS server for a first check

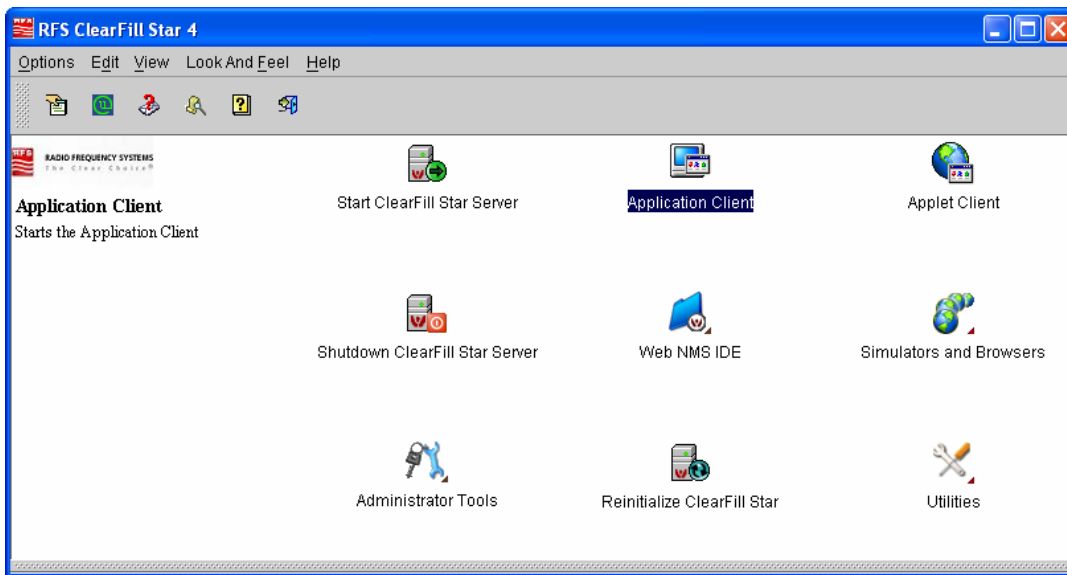
Please use keyboard and monitor attached to the started NMS server (see 4.7.1-Start of NMS Server).

1. The operating system prompts for a password.  
Default password is: **nmsadmin**.



After first login please change password according to corporate security guidelines.

2. Start the WEB NMS Launcher by clicking on the appropriate icon.
3. The NMS server is running an automatic device discovery routine. This routine should have automatically detected all devices within approximately 30 min. Please wait until discovery has finished and all elements of your topology are displayed.
4. Click on "Application Client" within the appearing Web NMS Launcher window (see Figure 36 Web NMS Launcher). The client is started.

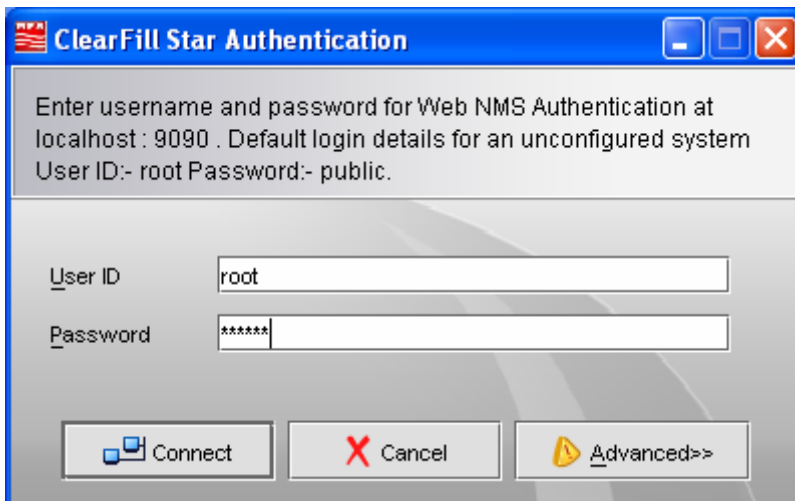


**Figure 36 Web NMS Launcher Window**

5. User is quoted for a password, default user name is “root”, default password is “public” (see Figure 37 ClearFill@Star authentication).

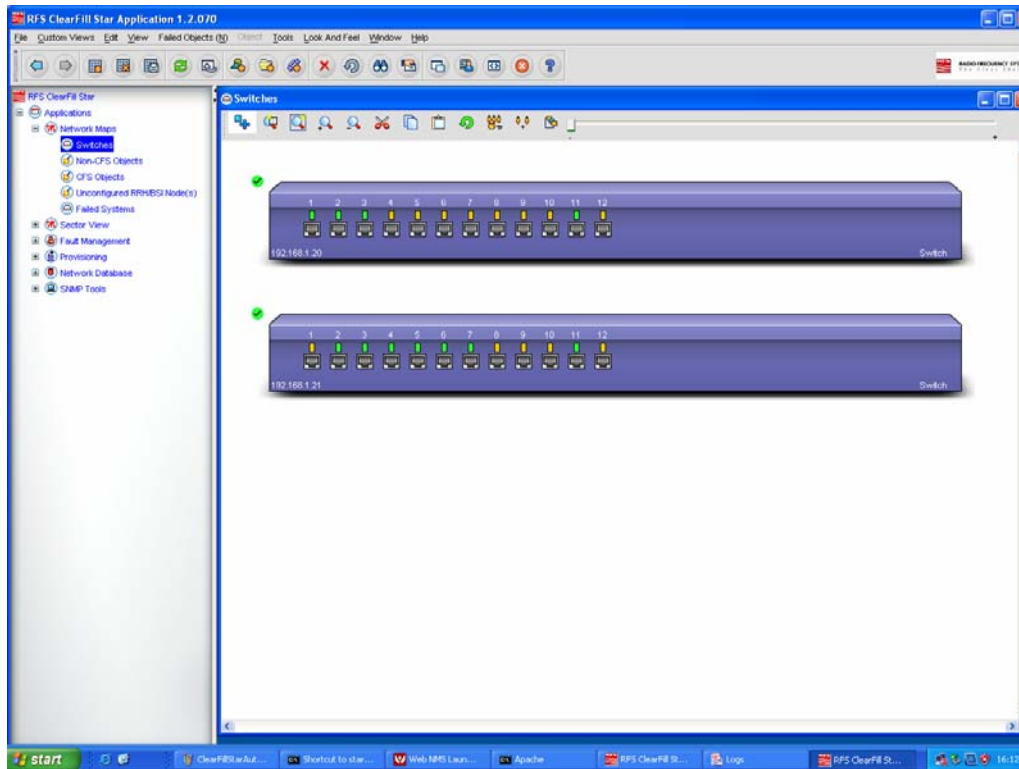


After first login please change password according to corporate security guidelines.



**Figure 37 ClearFill@Star authentication**

6. The client application appears. Open the Network Maps View (left side of screen), click on “Switches”. In the appearing menu all GES switches that have been installed before should be shown (see Figure 38). If not consult the network administrator.



**Figure 38 Network Map – Switches**

7. Open the Unconfigured RRH / BSI Nodes View. It should contain all RRH and BSI nodes that were installed before (see Figure 39). If not consult the network administrator.

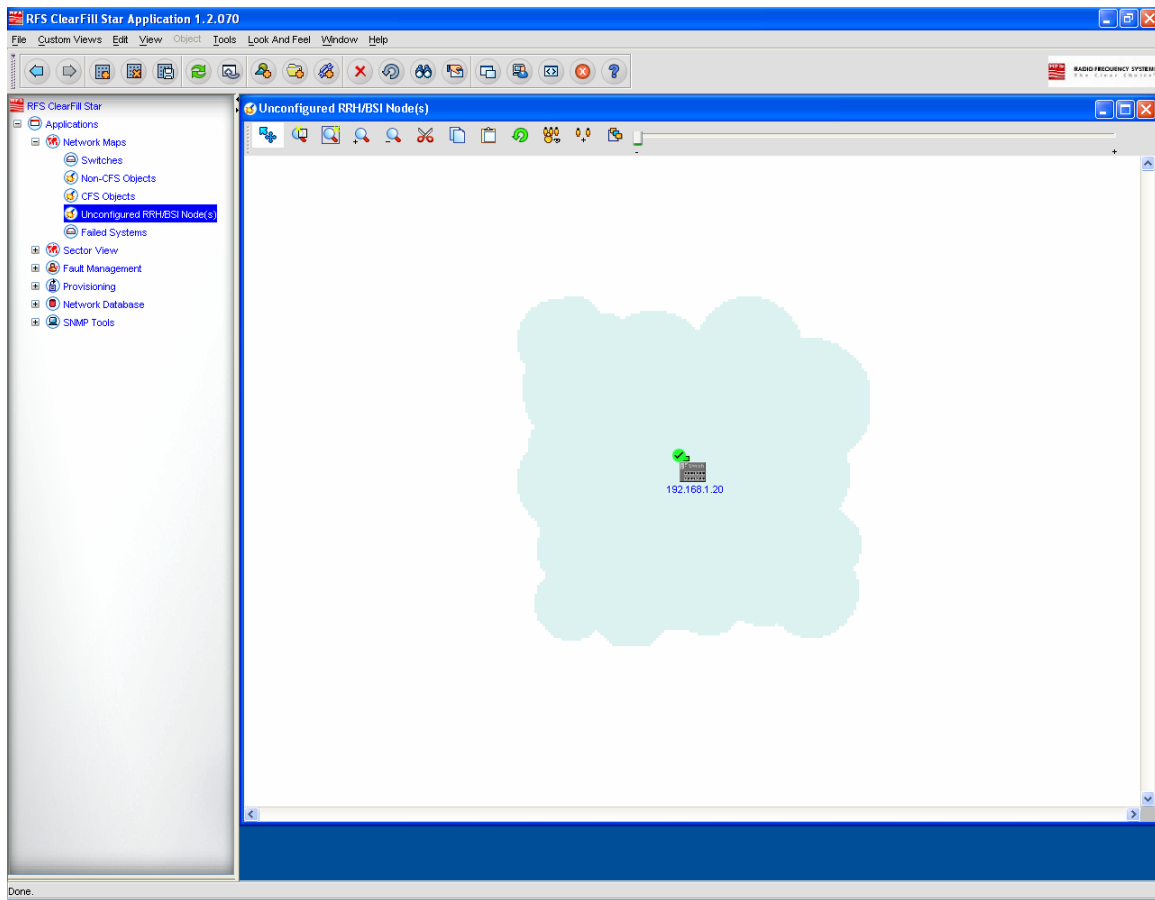


Figure 39 Network Map – Unconfigured RRH / BSI Nodes

#### 4.7.4 System optimization

In preparation

## 5 NMS Overview

### 5.1 Introduction

The ClearFill®Star Application Client presents the system management information in two different approaches. The first approach is the visual representation of the network elements in the form of graphical maps, which capture the topological or geographical organization of these elements. The second approach is an easy-to-access dynamic data representation with tables that list the aspects that are managed by ClearFill®Star NMS.

The managed aspects are:

- Fault management
- Performance management
- Provisioning

### 5.2 Starting the NMS

After having installed all hardware mechanically, switch on the NMS Server.

When the display shows the WindowsXP® start window, enter as the initial password: **nmsadmin**.



It is strongly recommended to change the password according to corporate security guidelines.



As the server is normally not connected to the Internet, the windows update function is disabled. It is up to the customer, to secure the network against potential viruses etc. RFS is not responsible for any faults arising from a virus attack against the server.

#### 5.2.1 IP address setup

The IP addresses of the GES can be setup statically or dynamically.

The disadvantage of static IP is that IP addresses must be setup individually.

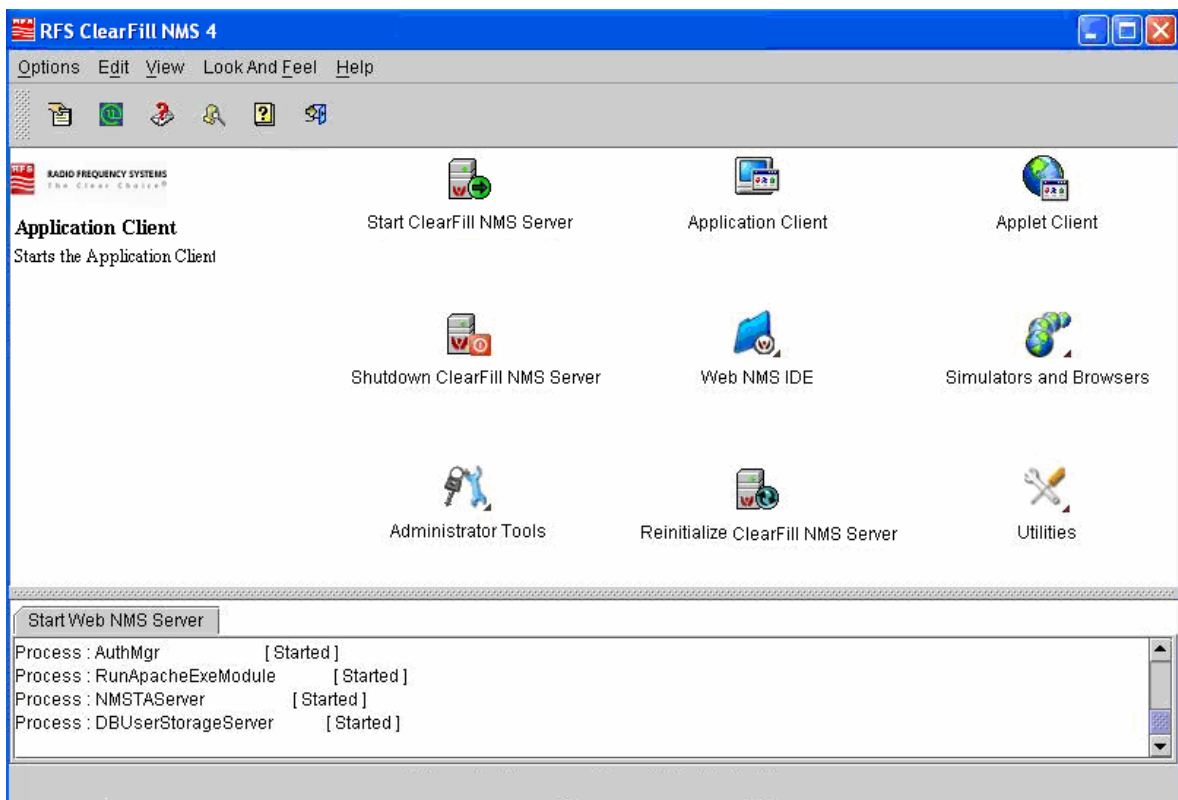
Dynamic IP addresses are also supported by the GBit switches. The procedure to set the IP addresses (dynamically or statically) is described in section 4.4.

## 5.3 Tools and Utilities of NMS server

This chapter describes the tools and utilities that are installed on the NMS server on delivery.

### 5.3.1 The Web NMS Launcher

The Web NMS Launcher is the central interface to start the NMS Application Client or any other RFS tool or utility. It is started by clicking on Web NMS Launcher icon which is placed on the windows desktop. See Figure 40 for the Web NMS Launcher window.



**Figure 40 Web NMS Launcher window**

The following sub menus are to be seen:

- **Start ClearFill NMS Server**  
This button starts the NMS application
- **Application Client**  
This button initializes the NMS client
- **Applet Client**  
For expert Modus
- **Shutdown ClearFill NMS Server**  
This button will shut down the NMS System
- **WEB NMS IDE**  
For expert Modus





- **Simulations and Browsers**

For expert Modus

- **Administrator Tools**

For expert Modus

- **Reinitialize ClearFill NMS**

Will clear all data bases and the log files on the server.

- **Utilities**

This button opens a sub menu with the following Icons:

- **Back**

Navigate back to the main menu

- **LDAP Client**

For expert Modus

- **Configuration File Checker**

For expert Modus

- **ObjectToRelational**

For expert Modus

- **Menu Configurator**

For expert Modus

- **I18N Editor**

For expert Modus

- **Discovery Configurator**

To discover the nodes on the network correctly, it is necessary to setup the network discovery when starting the NMS software the first time. Open “Utilities” and open up the “Discovery Configurator”.

- **Start ClearFill NMS Server**

To start the NMS, double-click on the icon. In the lower window, the task in progress will be displayed and an additional window (Apache) is opened. This window is to be minimized. When “Please connect your client to the web server on port 9090” is displayed, double-click the icon “Application Client” to start the client.

- **Application Client Starting**

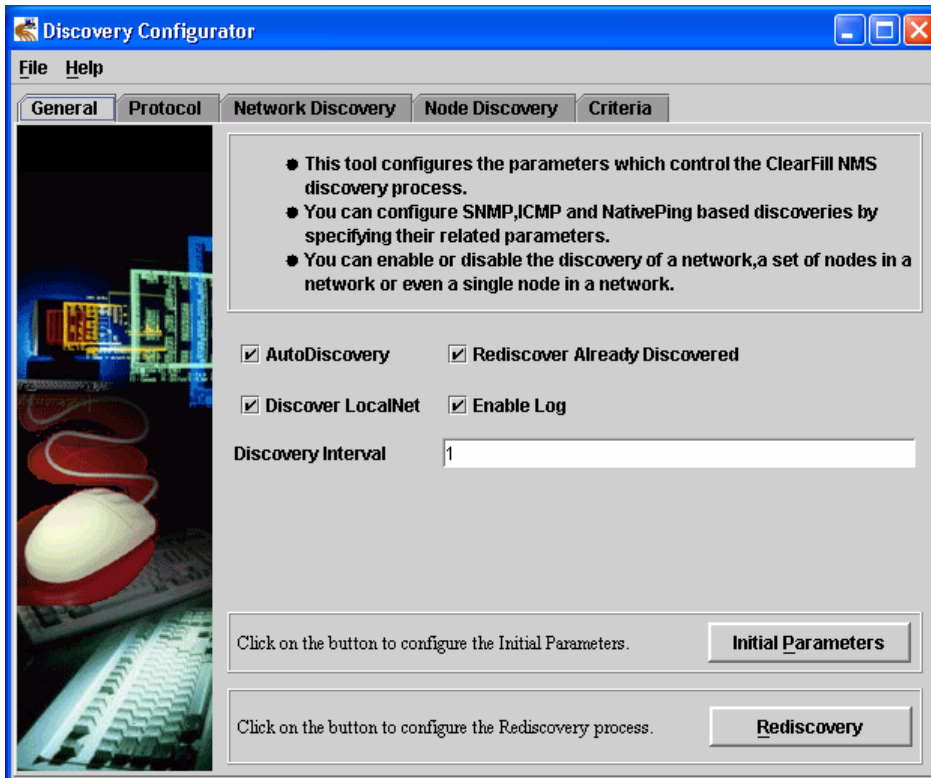
Double clicking this icon will start the NMS. When the applications client is started, the log in window will appear (see section 5.3.3).

### 5.3.2 Discovery Configurator

After starting the Discovery Configurator via the Web NMS Launcher (see section 5.3.1, submenu utilities) a multi tabbed window opens, initially displaying the General tab.



### 5.3.2.1 General Tab



**Figure 41 Discovery Configurator – General Tab**

In the General tab, the following options are available. Activate or deactivate them by clicking on the check mark symbol next to them.

- **AutoDiscovery**  
NMS does automatically add each node on the specified network
- **Rediscover Already Discovered**  
Enable the NMS to rediscover nodes that have already been discovered to check for status changes.
- **Discover LocalNet**  
NMS to discover nodes attached directly to the NMS server.
- **Enable Log**  
Enable creation of log file

Further more there are two buttons in the General Tab:

- **Initial Parameters**

Allows the user to manually define the parameters by which the NMS discovers the nodes on the network with respect to the following Discovery interval:

- Rediscovery interval
- ICMP Ping retries
- SNMP Timeout
- SNMP Retries
- NativePing Timeout
- NativePing Retries

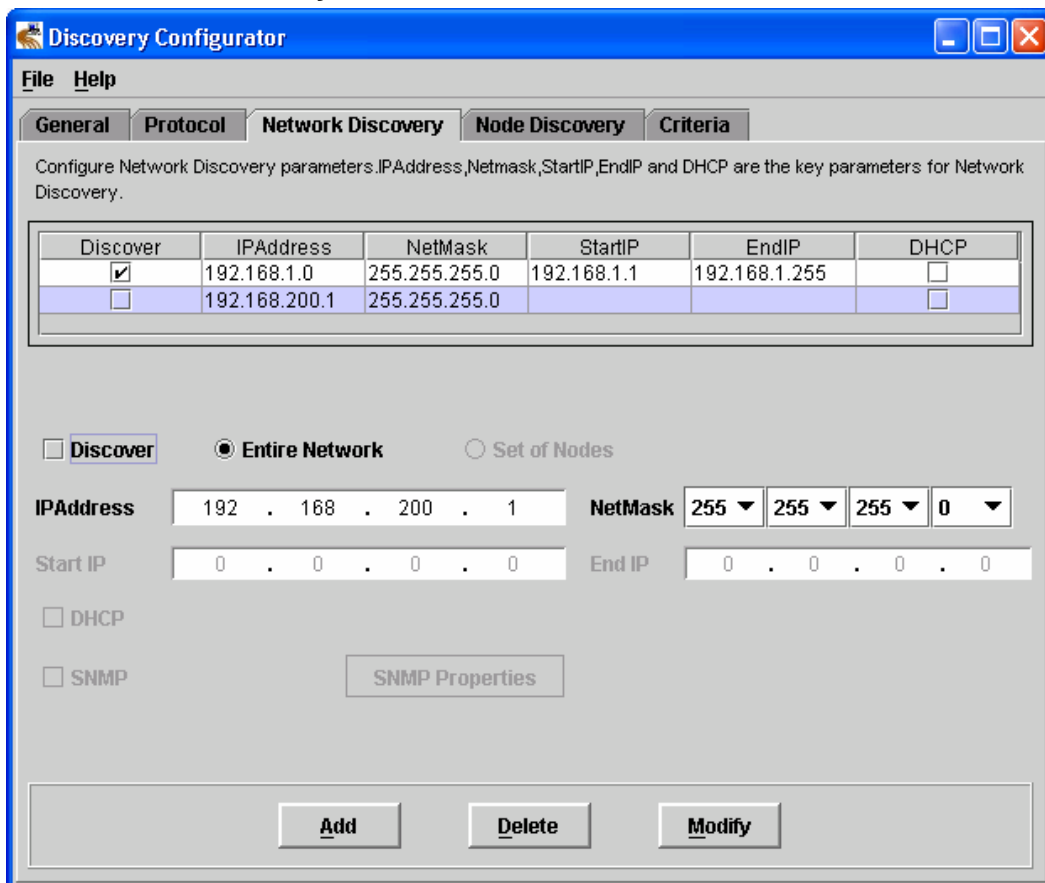
- **Rediscovery**

Open the Rediscovery Scheduler which allows the user to setup rediscovery at regular intervals, specific dates or days of the week.

### 5.3.2.2 Protocol Tab

In the Protocol tab, the protocols to use for communicating with the devices on the network are to be set. SNMP is the default the only supported protocol for the ClearFill NMS.

### 5.3.2.3 Network Discovery Tab



Discover	IPAddress	NetMask	StartIP	EndIP	DHCP
<input checked="" type="checkbox"/>	192.168.1.0	255.255.255.0	192.168.1.1	192.168.1.255	<input type="checkbox"/>
<input type="checkbox"/>	192.168.200.1	255.255.255.0			<input type="checkbox"/>

Discover   
  Entire Network   
  Set of Nodes

IPAddress: 192 . 168 . 200 . 1   
 NetMask: 255 ▾ 255 ▾ 255 ▾ 0 ▾

Start IP: 0 . 0 . 0 . 0   
 End IP: 0 . 0 . 0 . 0

DHCP   
 SNMP   

Figure 42 Discovery Configurator - Network Discovery tab



In the Network Discovery tab, following options are available:

- **Network to search**  
Checkmark each network to search for ClearFill Star Elements in the Discover column.
- **Discover**
  - **Entire Network**  
For a complete discovery. This may take about 30 minutes
  - **Set of Nodes**  
Define a range of IP addresses to be searched with net mask, the start IP and end IP
- **DHCP**
- **SNMP**
  - **SNMP Properties**

#### 5.3.2.4 Node Discovery Tab

The Node Discovery tab allows the user to add single nodes manually. This may also be done in the Application Client, which is covered later on.

#### 5.3.2.5 Criteria Tab

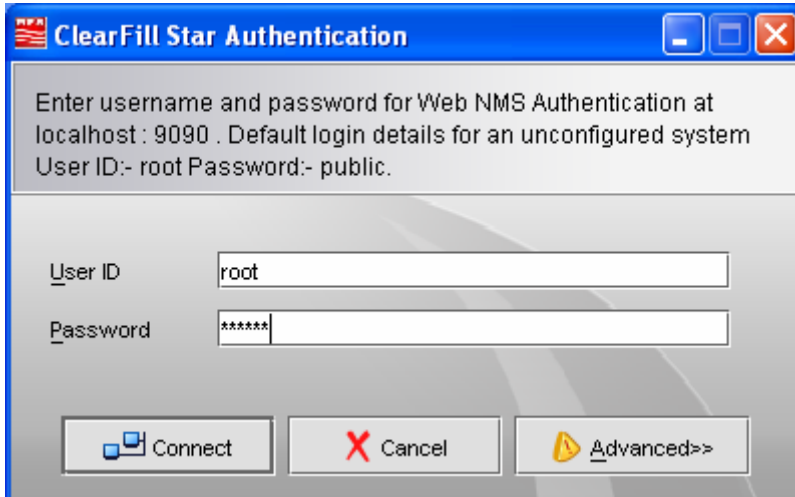
The Criteria tab allows the user to further define which nodes are added to the NMS based on following criteria:

- Property Name
- Property Value



### 5.3.3 ClearFill Star Client Login Window

Upon startup of the ClearFill Star Client, the login window appears. The user is asked to enter a user ID and password to log in to the system.



**Figure 43 Login Screen**

Default account:

Username: **root**

Password: **public**

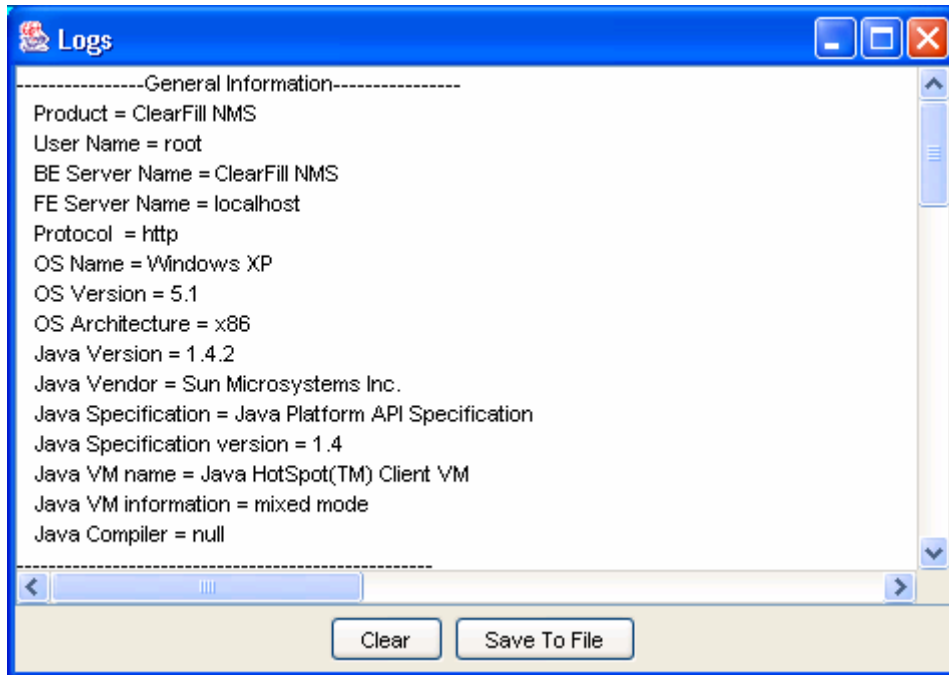
And click "Connect"



There is also an option to login remotely, that option is described in section 7. The remote options are accessible via the Advanced button, which is ignored in this section.

### 5.3.4 Logs Window

Upon start-up of the Application Client the Logs window appears. This window displays general information on the current system and will display feedback from the NMS with regard to actions and services. It also displays system error messages.



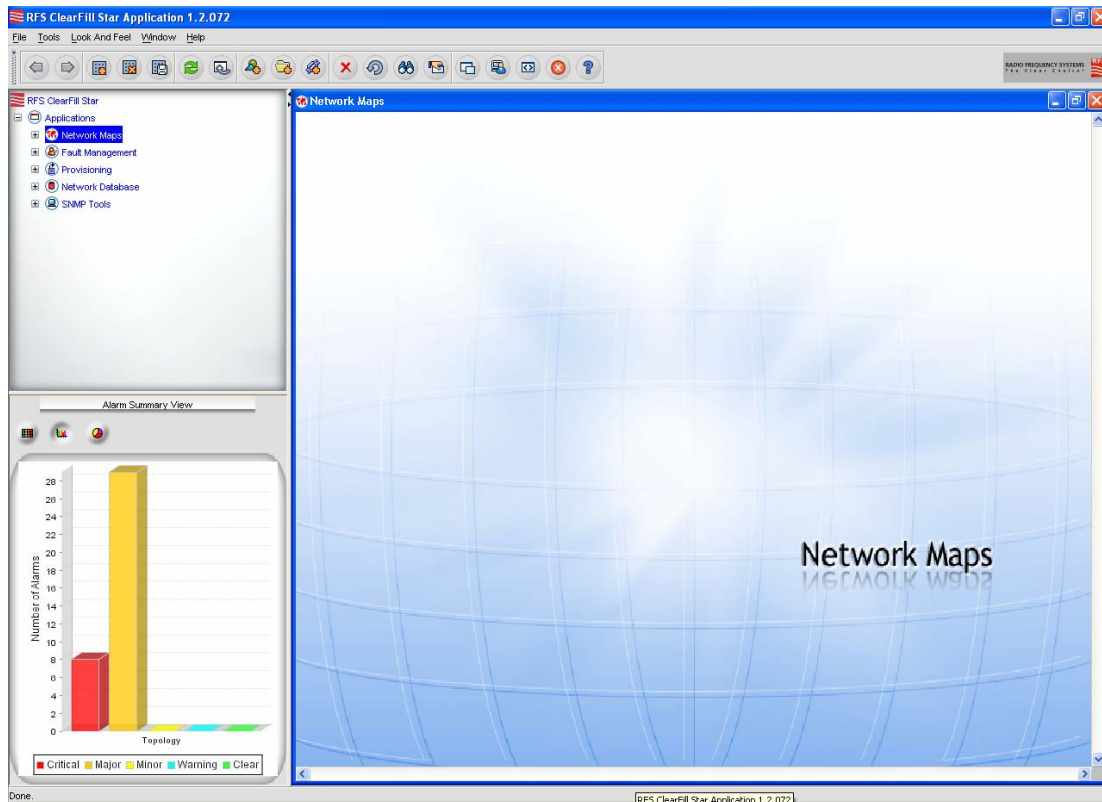
**Figure 44 Logs Window**

## 5.4 Main Window of NMS Application Client (structure)

The ClearFill®Star Application Client is the main tool to configure and maintain the ClearFill®Star System. It is started via the Web NMS Launcher (see section 5.3.1).

After having started the NMS Client, two main windows appear:

- The Application Client with the default display for the Network Maps
- The Logs window (see section 5.3.4)



**Figure 45 Application Client Screen**

### Layout

The Application Client has the classic Windows style, three pane look and feel with following elements:

- Menu Bar
- Display Pane
- Tree Pane
- Alarm Summary Pane

### 5.4.1 The Menu Bar

The menu bar is placed at the top edge of the display area.

The menu bar differs from screen to screen based on the functions and also based on privileges of logged in user.

For instance, the Fault Management module has additional menu items for users with administrator rights, such as Actions and Custom Views. But certain menu items, also available for users with standard rights.

### 5.4.2 The Tree Pane

The Tree Pane contains different nodes that unfold when clicking on the node name or on the plus sign in front of the node name. The upper most node is called Applications, it contains these applications with following sub nodes:

- Network Maps
  - Switches
  - Non-CFS Objects
  - CFS Objects
  - Unconfigured RRH/BSI Node(s)
  - Failed Systems
  - Configured RRF/BSI Node(s)
- Fault Management
  - Network Events
  - Alarms
- Provisioning
  - Templates
  - Activity List
- Network Database
  - Networks
  - Nodes
  - Interfaces
  - Switches
  - ClearFill Star BSI
  - ClearFill Star RRH
- SNMP Tools
  - MIB Manager
  - SNMP V3 Security



The displayed nodes are visible when logged in user has administrator rights. Some of them are not visible when user has less user privileges.

Each of these nodes and their sub nodes are explained in the following sections.



### 5.4.3 The Display Pane

The display pane is on the right-side of the Application Client window and appears as a window within the main window. This panel shows details of the tree node that is selected in the tree pane (see section 5.4.2). If for example Fault Management and on one of the appearing nodes is selected in Tree Pane (like Network Events or Alarms), the information of the selected node is shown in the Display pane.

### 5.4.4 The Alarm Summary Pane

The Alarm Count panel shows an overview of the current alarms, sorted by their severity (major, minor, critical, etc.). The Alarm Count panel is located below the Application Client Tree Panel (left-hand side). Clicking on an alarm count of a specific severity displays the corresponding Alarm panel. This panel is updated automatically and in view any time, independent of the functional view.

## 5.5 The NMS client functionality



This chapter describes the functionality of the ClearFill Star Application Client. The way how to navigate to these applications and their sub nodes is described in section 5.4.2

### 5.5.1 Network Maps

The ClearFill NMS server automatically discovers ClearFill®Star network elements. All discovered network elements are presented parallel in two different formats: Maps and Databases.

Network Maps are a graphical presentation, whereas Network Databases are textual (lists).

In general the same functions are accessible with both formats, but in certain situations one format may turn out to be more convenient than the other. This is highly dependant on the task to do and the user preferences.



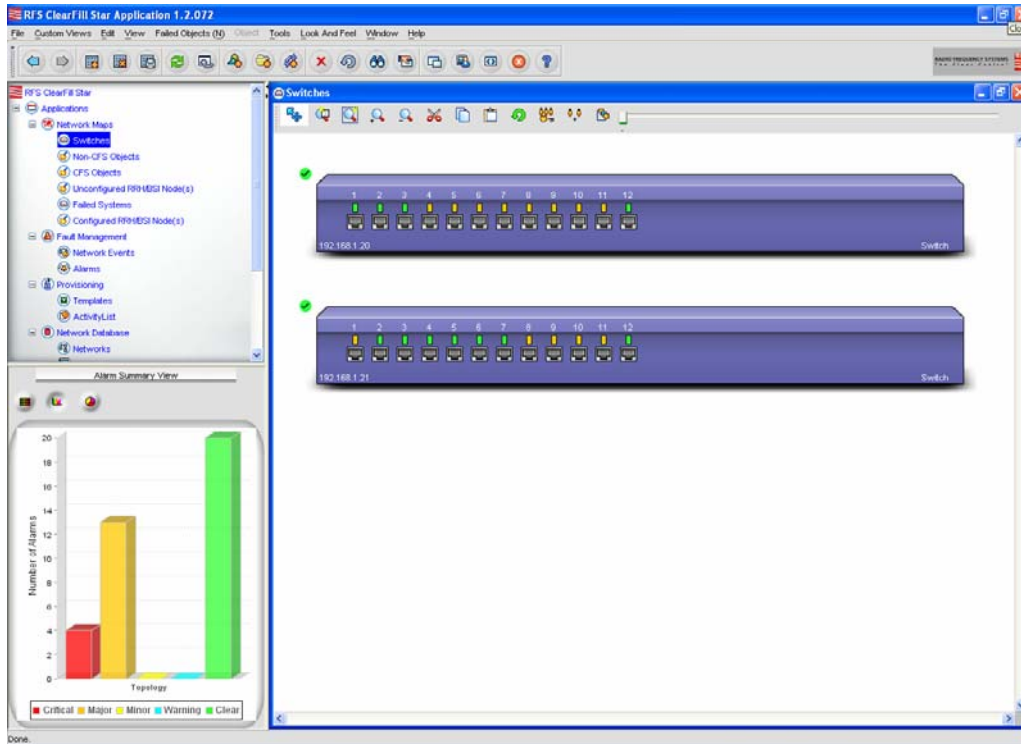
This section explains the ClearFill®Star maps and the operations that can be performed with Network Maps. See section 5.5.4 for the Network Database explanations.

Select Network Maps in the tree view pane. While only the main node is selected the view on the right-hand pane is blank (an image), but in the tree view on the left hand pane these nodes are selectable.

- Switches
- Non-CFS Objects
- CFS Objects
- Unconfigured RRH/BSI Node(s)
- Failed Systems
- Configured RRH/BSI Node(s)

### 5.5.1.1 Switches

Each discovered switch is presented as a schematic image of a switch front panel. Figure 46 shows an example of the switch view (with two switches in the network).



**Figure 46 Switches**

Every single port on the schematic switch drawing is either orange (no connection detected) or green (connected). In the lower left corner the IP address of the switch is visible.

### 5.5.1.2 Non-CFS Objects

Objects that have been found on the network and do not match the ClearFill®Star criteria are listed in the Non-ClearFill Objects tab. These objects may include the following:

- NMS appliance
- NMS Client
- Routers
- Printers
- PC and any other network device

Figure 47 shows an example of a map view for Non-ClearFill objects:

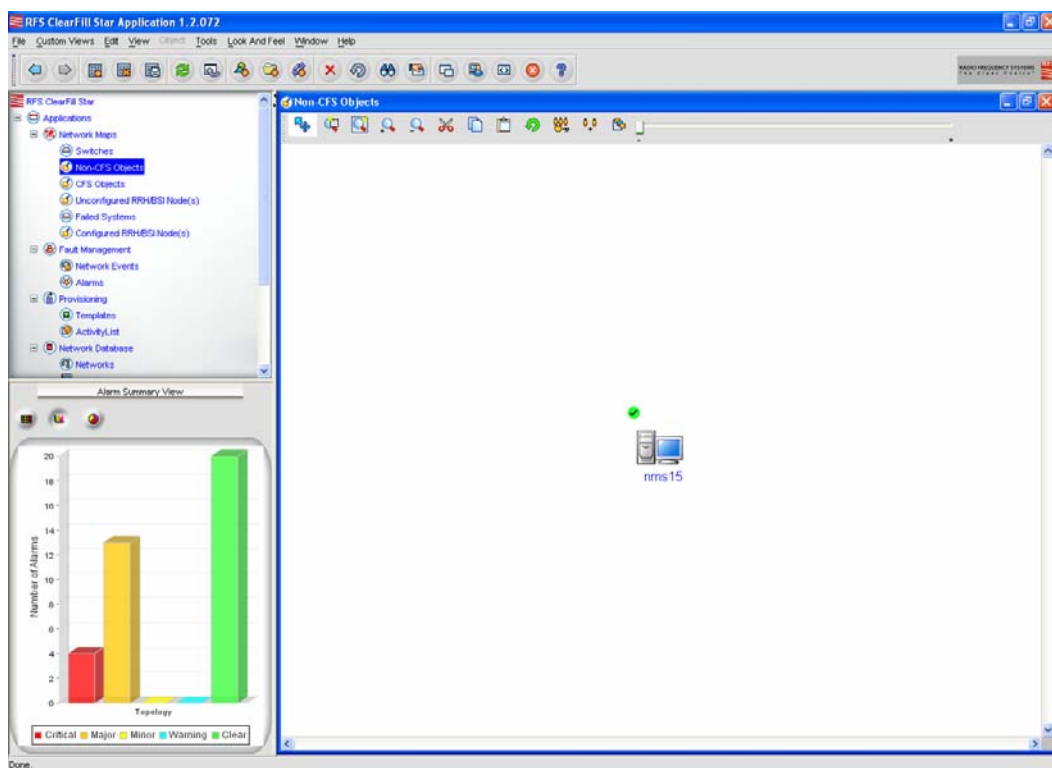


Figure 47 Map View for Non ClearFill devices

### 5.5.1.3 CFS Objects

Objects that meet the ClearFill®Star criteria are listed under ClearFill Objects. Listed devices include:

- BSI
- RRH
- Switches

Each node is presented with these features in every map view:

- IP Address
- Online / Offline status (Active / Failed)

Figure 48 shows an example of a map view with ClearFill®Star objects.

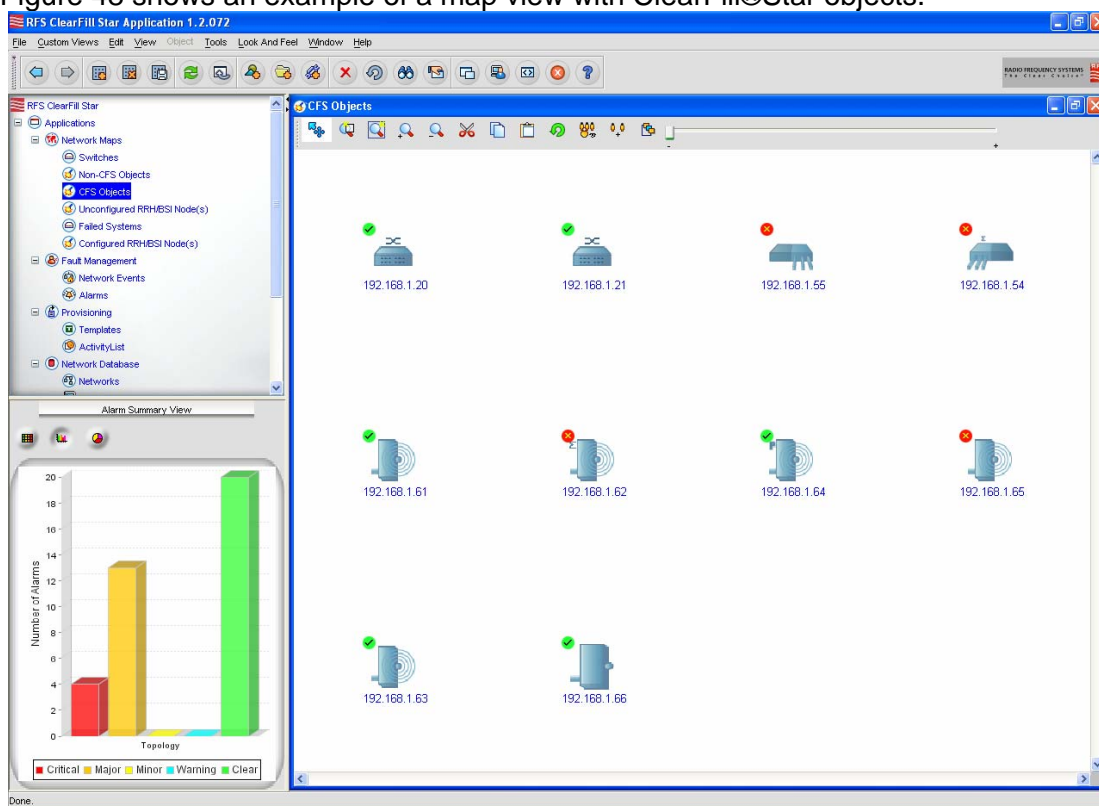


Figure 48 ClearFill®Star objects map

#### 5.5.1.4 Unconfigured RRH/BSI Node(s)

This map displays all BSIs and RRHs that are not configured for any sector. Devices shown in this map have their sector id set to zero. See Figure 49 for an example view.

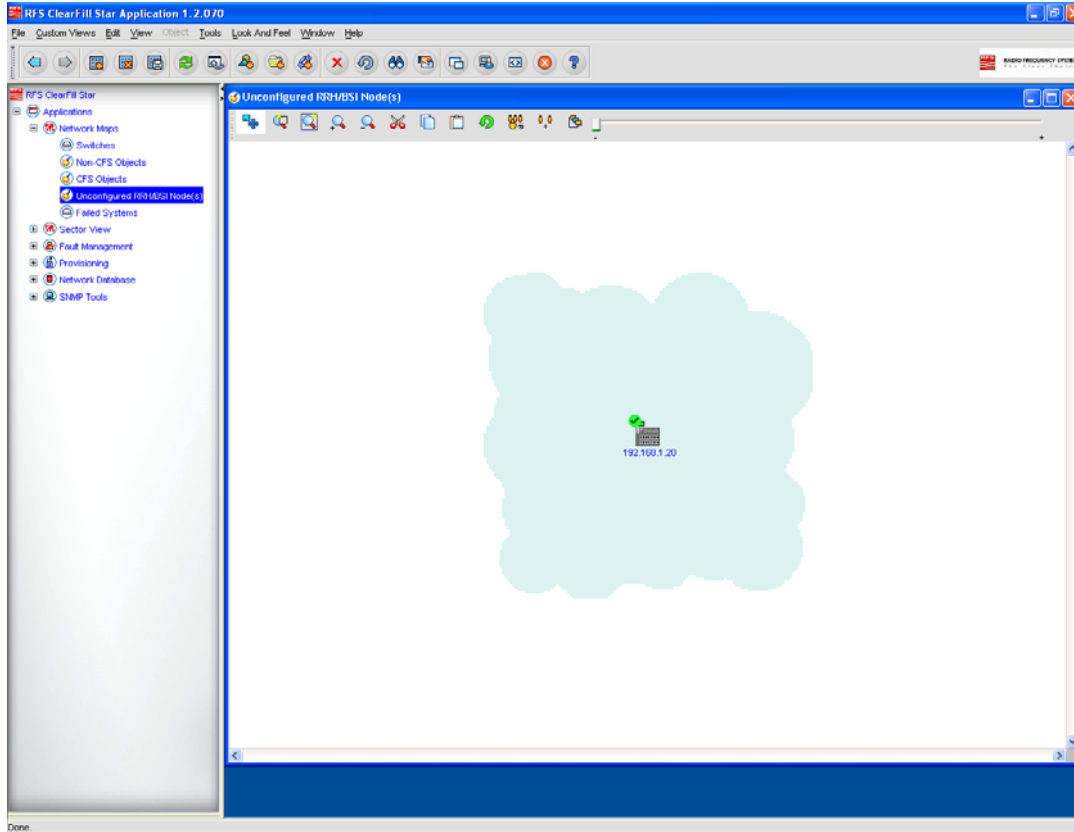


Figure 49 Unconfigured Devices Map

### 5.5.1.5 Failed Systems

This map shows graphically each failed ClearFill®Star element on the network. Figure 50 shows an example for the failed nodes map view.

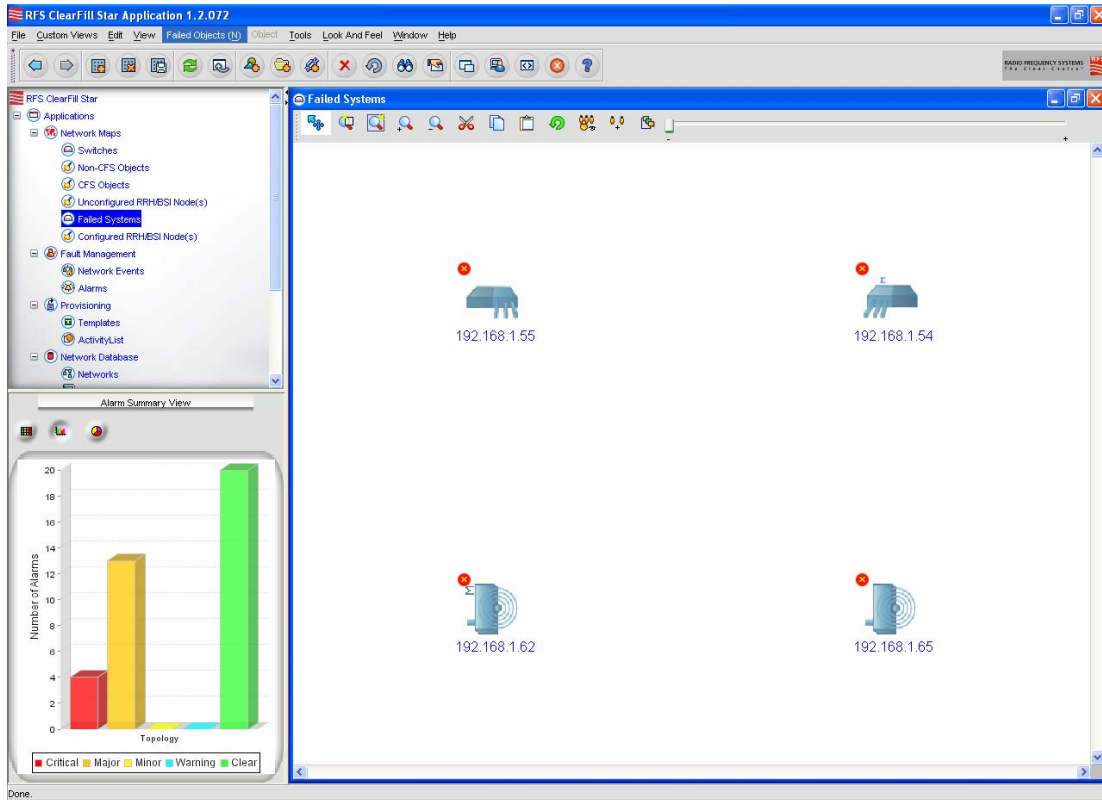


Figure 50 Failed Systems map

### 5.5.1.6 Configured RRH/BSI Node(s)

The configured RRH/BSI nodes view shows all devices that are already configured. See Figure 51 for a map view of the configured ClearFill®Star devices. Devices are considered to be configured when the sector id is configured to be unequal zero.

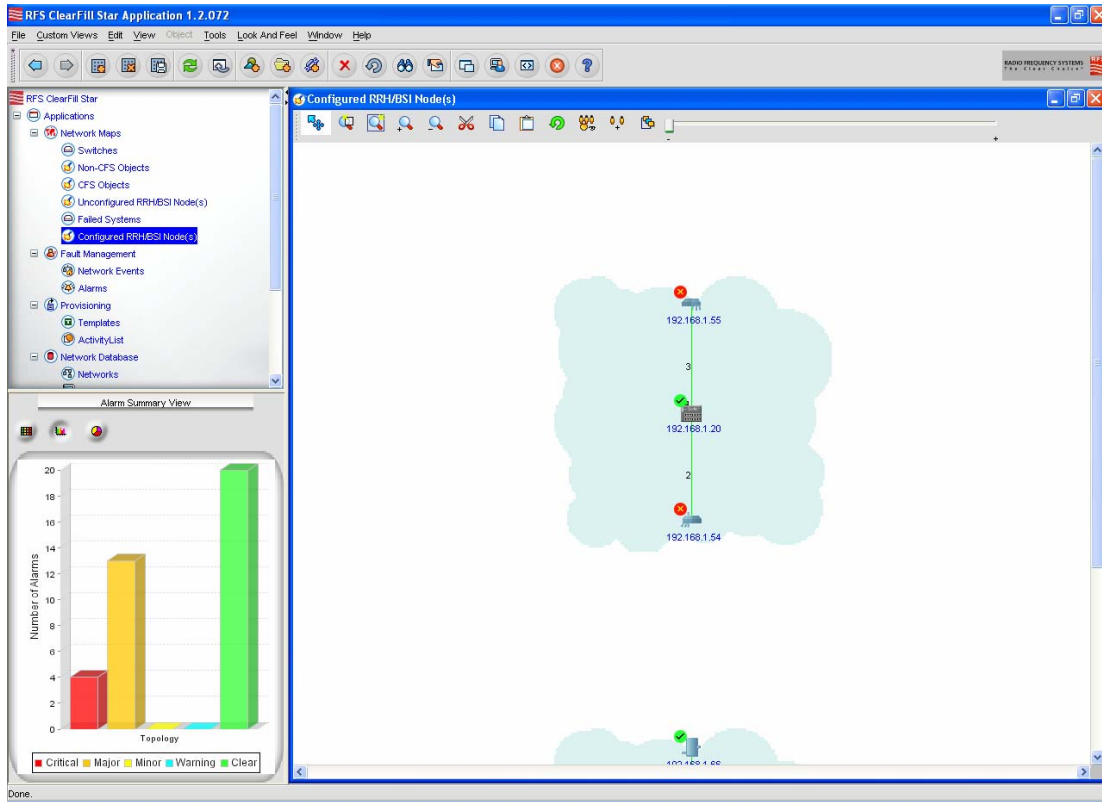


Figure 51 Configured BSIs and RRHs map view



## 5.5.2 Fault Management

### 5.5.2.1 Network Events

All network events are logged. They are displayed in the network events tab. See Figure 52 for an example for the network events view. The background color of each event informs users of the nature of the event.

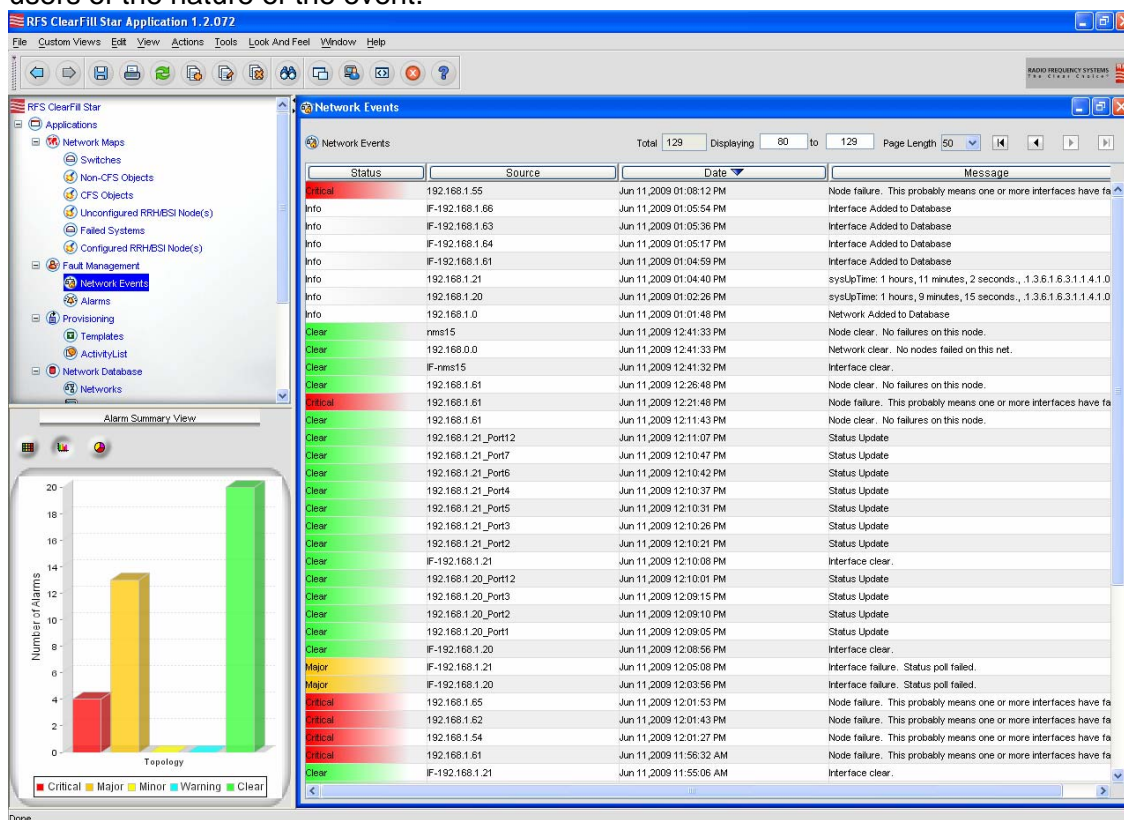


Figure 52 Network events view







### 5.5.2.2 Alarms

All Alarms are logged and displayed in the Alarms view. See Figure 53 for an example alarms view.

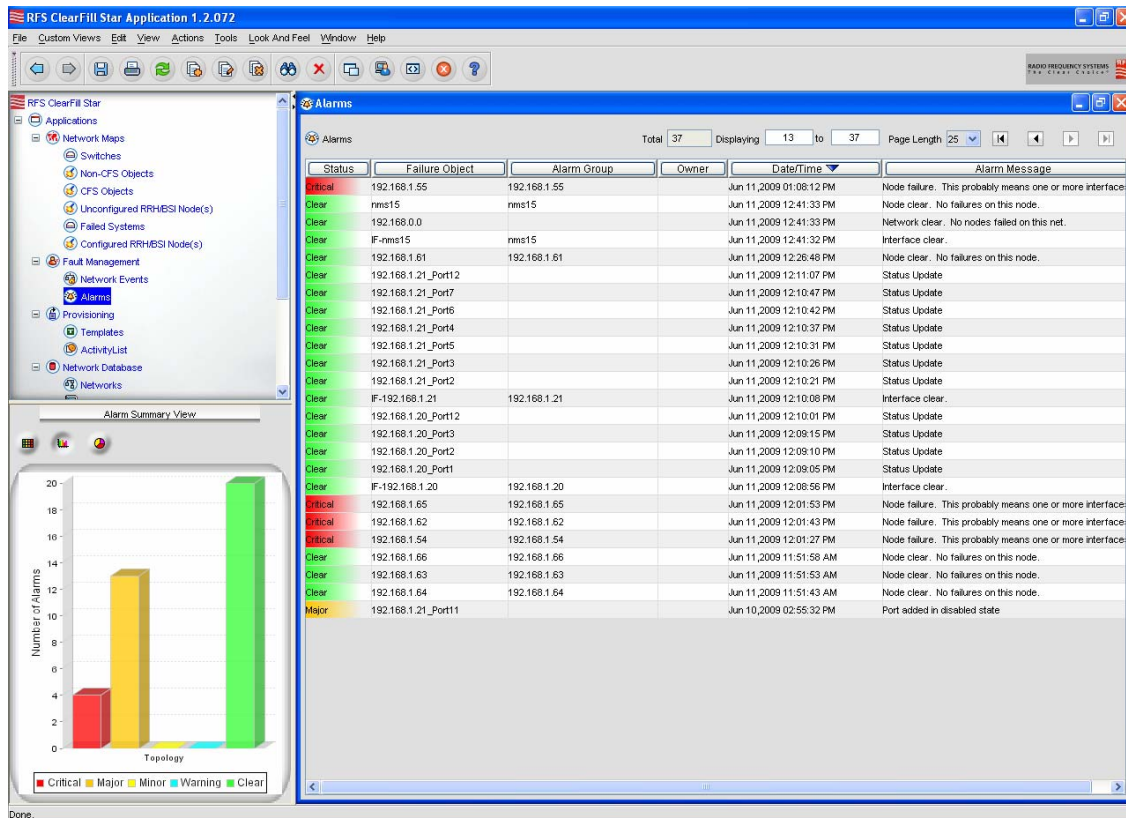


Figure 53 Alarms view



## 5.5.3 Provisioning

### 5.5.3.1 Templates

The provisioning tab contains the template collection to provision the ClearFill®Star network elements. The lists of templates available to the user are as follows:

- AddClearFillObj
- DeviceConfig
- FirmwareDownload
- RemoveSector
- SectorConfiguration
- SectorPilotConfiguration

See Figure 54 for an example of the provisioning templates view.

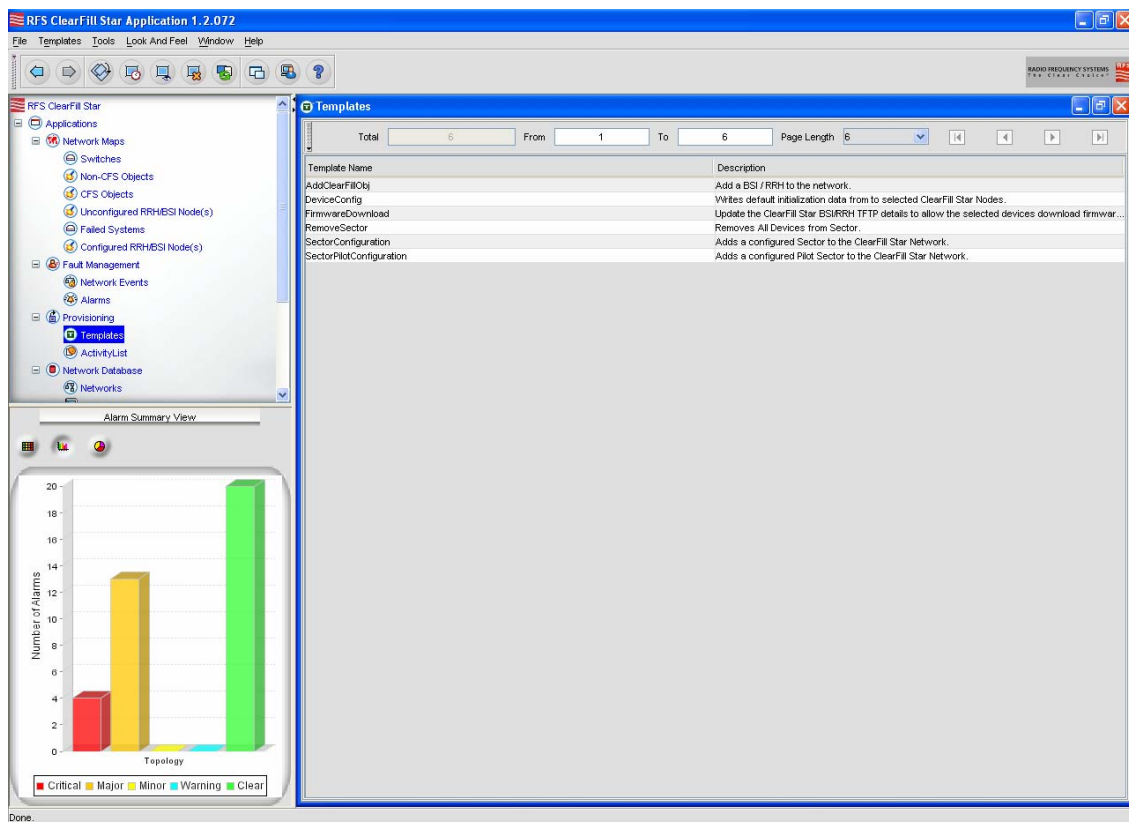


Figure 54 Templates Display Panel

### Invoking Provisioning Templates

Click on the Provisioning tab

Click on the templates child tab. A table of templates will appear in the Display Panel as in the screen shot above.

Perform any of the following procedures to start the execution of a template:

- Right-click a row on the table and select Provision
- Double-click a row on the table
- Click a row in the table and from the Templates menu, choose Provision
- Click a row in the table and press Shift + Ctrl + P

#### 5.5.3.1.1 Add Clear Fill Object

The AddClearFillObj provisioning template can be used to add a ClearFill Object which was not discovered during the discovery process or which was added to the network after discovery had finished. Double click the template name to start procedure and follow this walk through. See Figure 55 for the AddClearFillObj template.

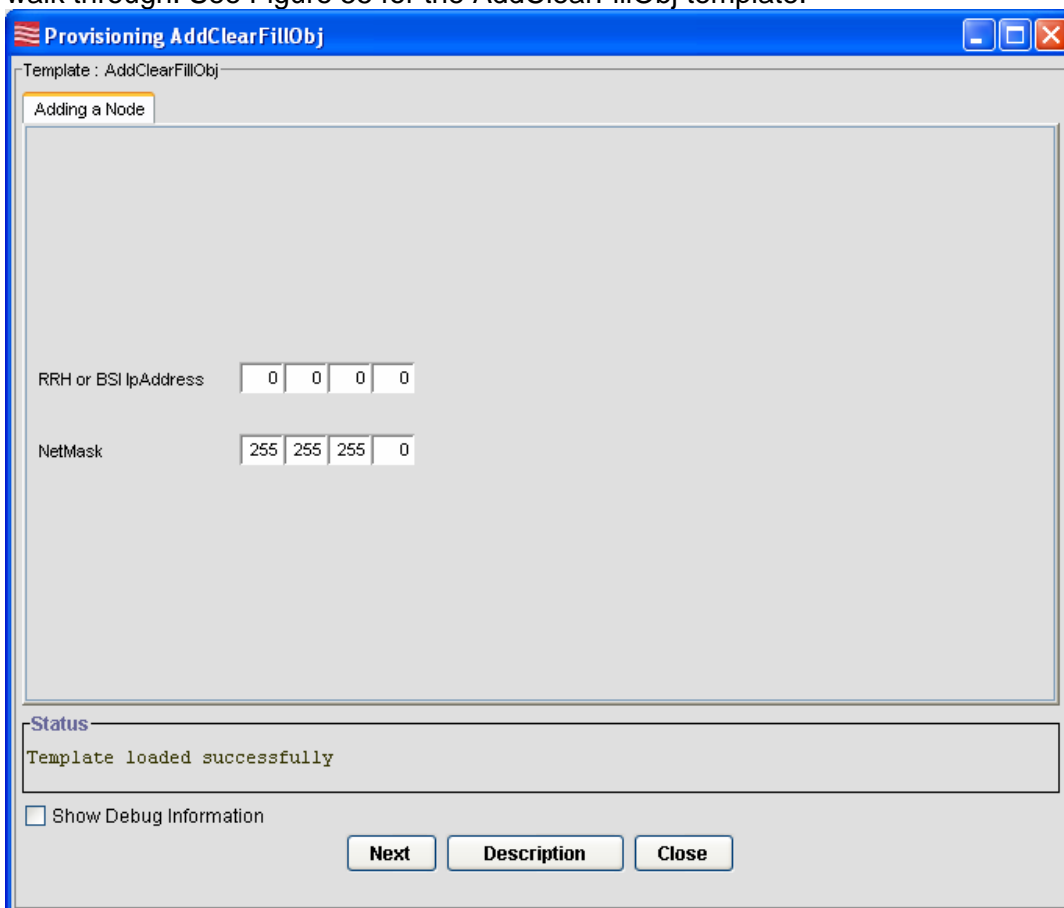
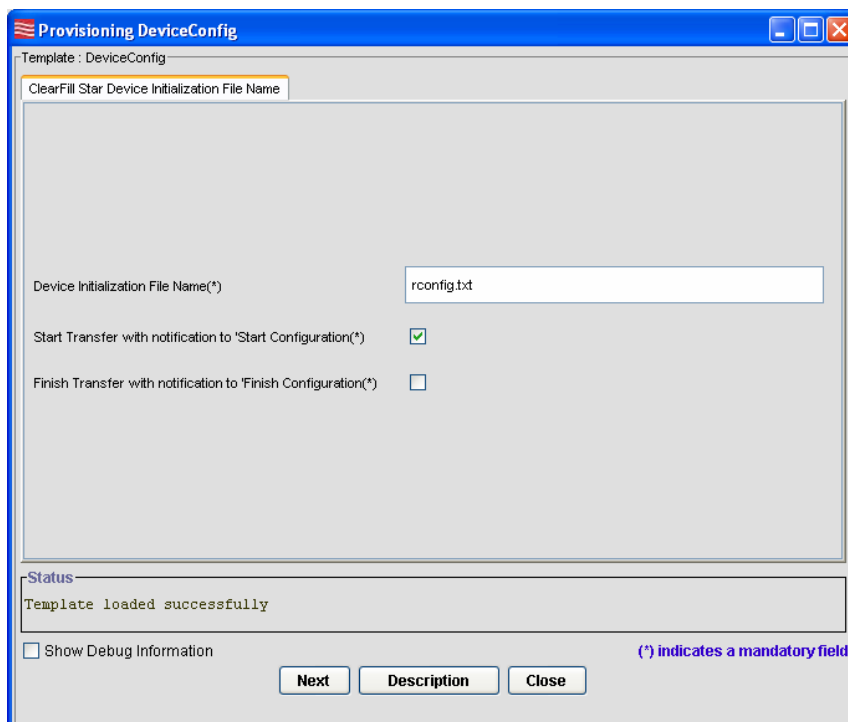


Figure 55 AddClearFillObj provisioning template

Enter the IP address and NetMask of the Node to be added to the ClearFill@Star network. Click on Next button to add the node to the NMS. It will appear in its relevant Network Map shortly after the window has closed.

### 5.5.3.1.2 Device Configuration

The DeviceConfig provisioning template allows the user to setup ClearFill®Star elements with a standard default template. See Figure 56 for an example screen shoot. Double click on the template name and follow this walk through.



**Figure 56 DeviceConfig provisioning template**

Enter the name of the file to be used for the provisioning. The provisioning file must be in the TFTP directory of NMS server. Use the check boxes behind 'Start Configuration' and 'Finish Configuration' to enable or disable the notifications at the beginning and end of the provisioning loops.

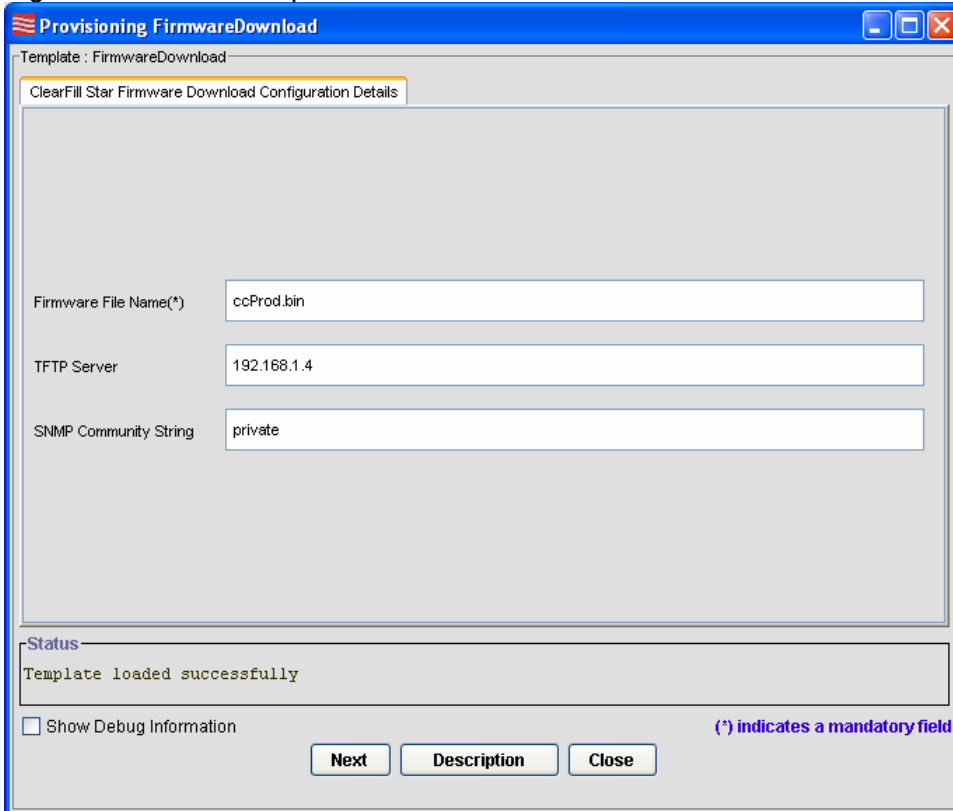
The template will then request which RRHs and BSI's are to be configured.



RRHs and BSIs must be configured separately as they require different template files.

### 5.5.3.1.3 Firmware Download

The firmware download template is used to update ClearFill®Star network elements. See Figure 57 for an example screen shoot.



The screenshot shows a window titled "Provisioning FirmwareDownload" with a subtitle "Template : FirmwareDownload". The main area is titled "ClearFill Star Firmware Download Configuration Details" and contains three input fields:

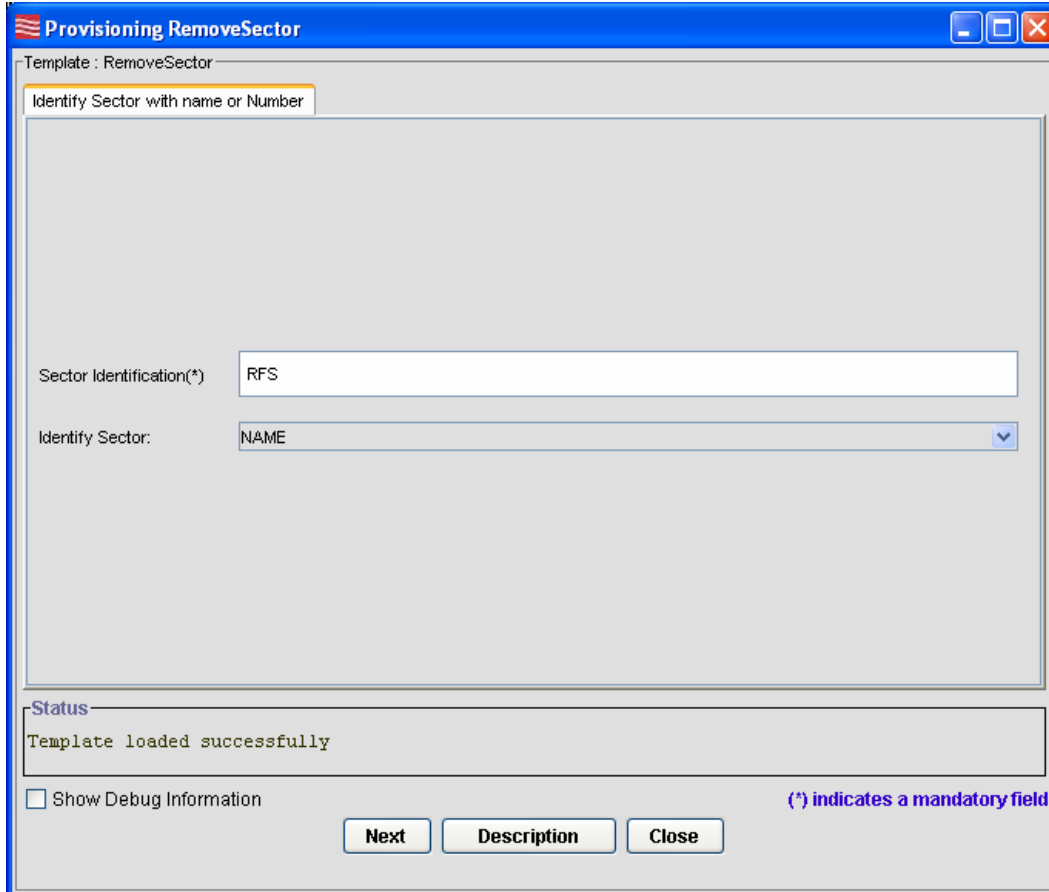
- Firmware File Name(\*) : ccProd.bin
- TFTP Server : 192.168.1.4
- SNMP Community String : private

Below the input fields is a "Status" section with the text "Template loaded successfully". There is a checkbox for "Show Debug Information" and a note "(\*) indicates a mandatory field". At the bottom are three buttons: "Next", "Description", and "Close".

Figure 57 Firmware download template

### 5.5.3.1.4 Remove Sector

The remove sector template is used to remove the sector from a ClearFill®Star network. This may be done the first time the system is started or later if the sector configurations have to get changed. Double click on the template name and follow the walk through instructions to remove a sector.



Provisioning RemoveSector

Template : RemoveSector

Identify Sector with name or Number

Sector Identification(\*) RFS

Identify Sector: NAME

Status

Template loaded successfully

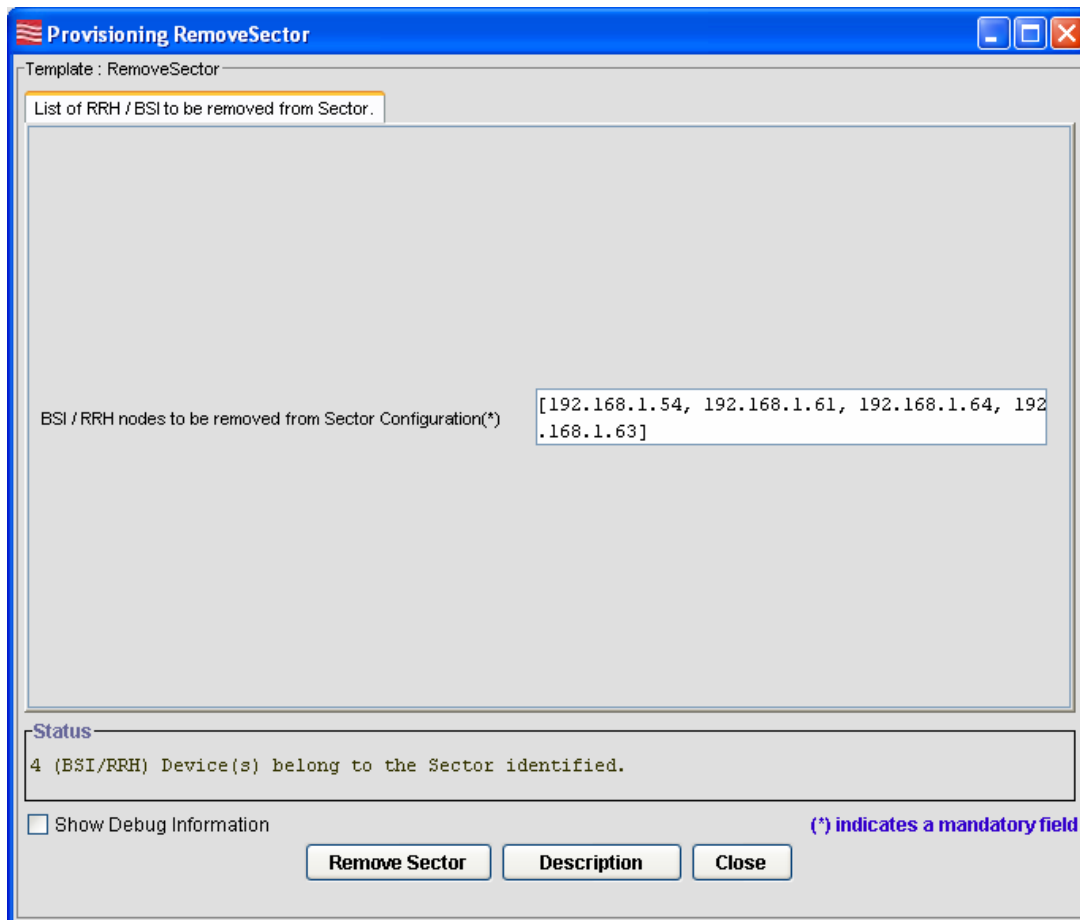
Show Debug Information

(\*) indicates a mandatory field

Next Description Close

Figure 58 Remove Sector step 1

Step 1: Enter sector identification with by name or by number. Use the drop down list (identify sector) to choose whether the entered sector identification is a sector name or a sector number.



Provisioning RemoveSector

Template : RemoveSector

List of RRH / BSI to be removed from Sector.

BSI / RRH nodes to be removed from Sector Configuration(\*) [192.168.1.54, 192.168.1.61, 192.168.1.64, 192.168.1.63]

Status

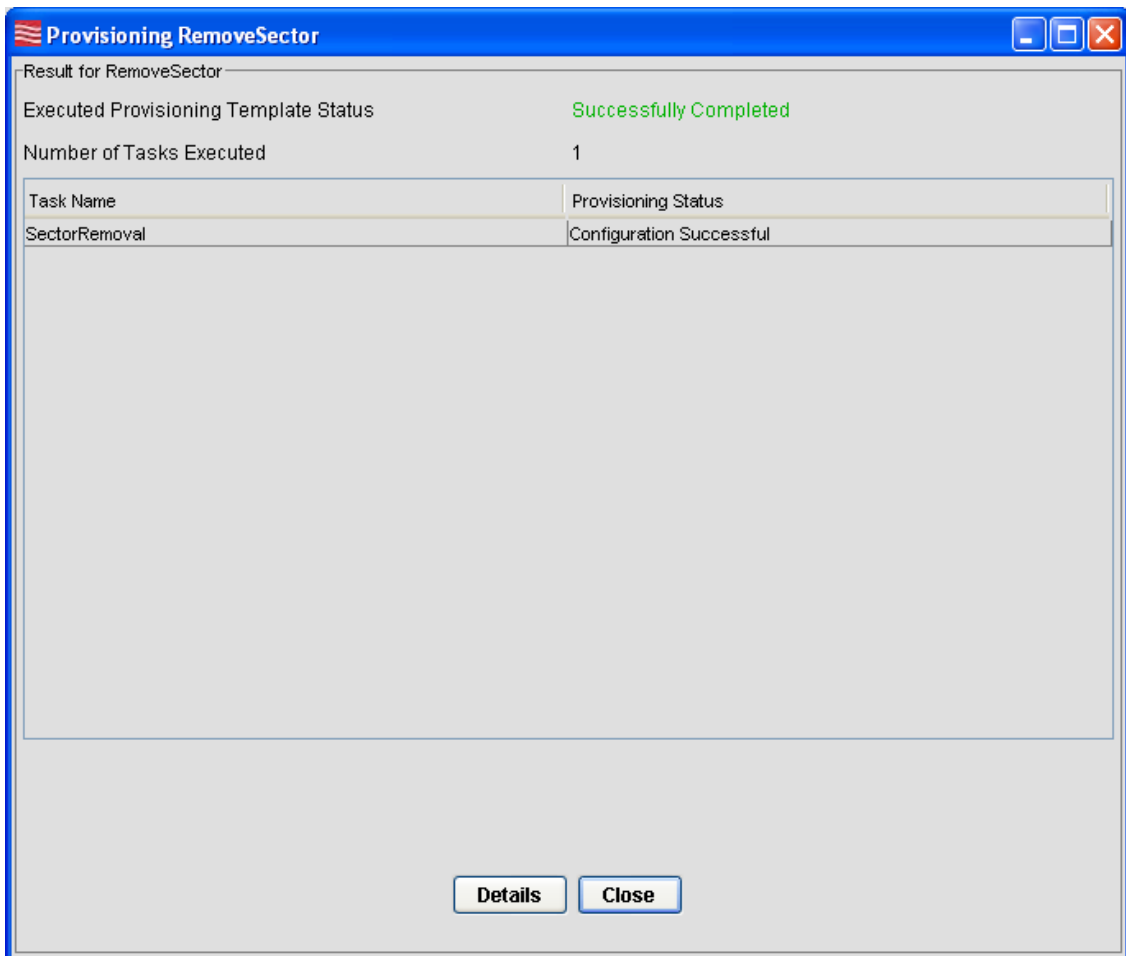
4 (BSI/RRH) Device(s) belong to the Sector identified.

Show Debug Information (\*) indicates a mandatory field

Remove Sector Description Close

**Figure 59 Remove Sector step 2**

Step 2: All devices that belong to the sector are listed. Click on Remove Sector button to remove the configured sector information from the listed devices and thus clear the sector.



**Figure 60 Remove Sector step 3**

Step 3: Finally all removed devices are listed. All tasks that had to be done to remove the sector are listed. The status of each task is also listed. If any task is not in state successful the sector has not been completely removed. Any trouble reports have to be solved before a new sector is configured.



### 5.5.3.1.5 SectorConfiguration

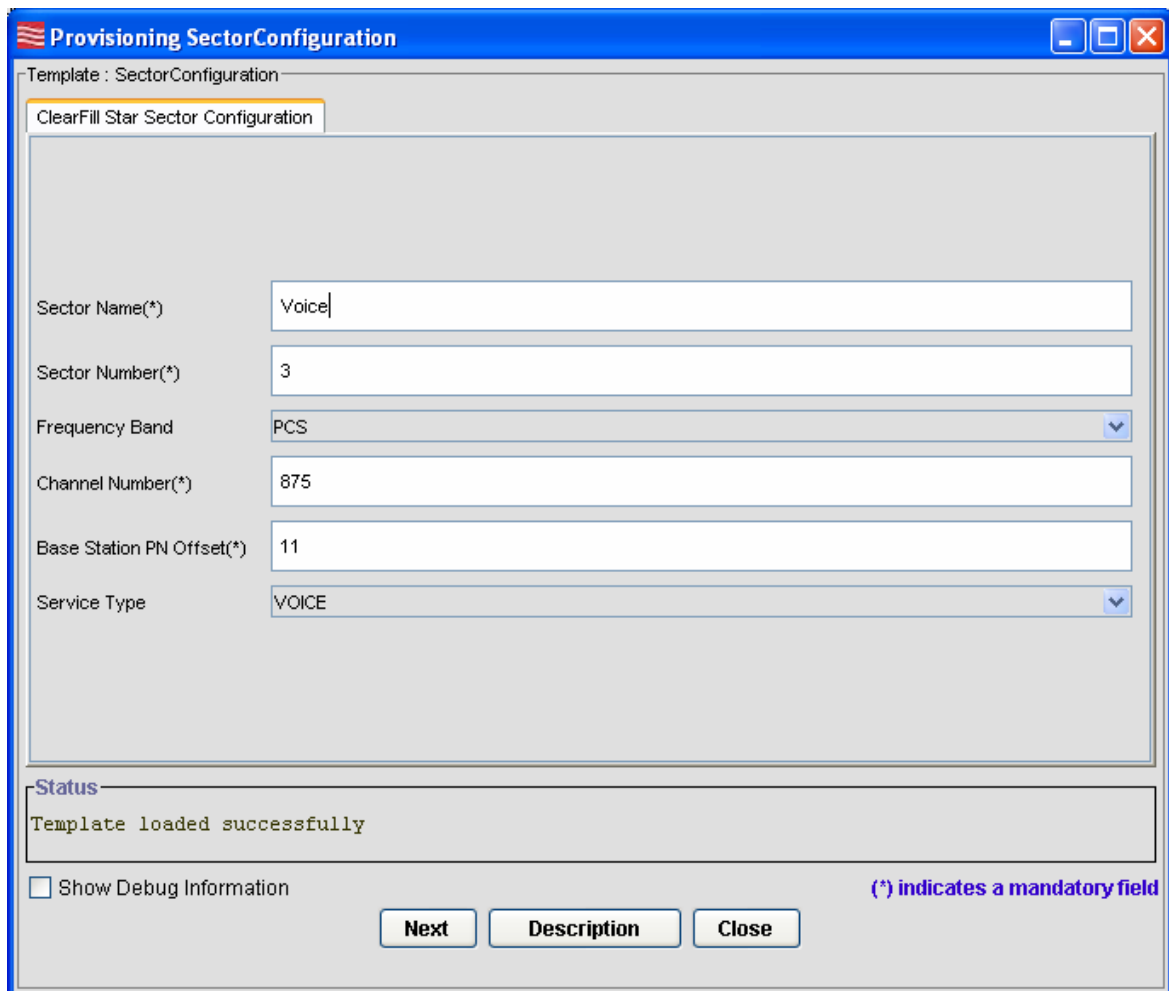
The sector configuration template is used to setup new sector. All devices that are supposed to belong to a sector are selected from a list. Afterwards the sector information is written to every selected device. There are three types of sectors:

- Voice (sometimes including pilot beacons)
- Data
- Pilot beacon.

This template is used to setup voice and data sectors. It is also used to configure voice sectors that include one or more pilot beacons.

The sectors that provide only pilot beacon functionality are configured with template SectorPilotConfiguration.

Please follow this walk through to configure a voice or a data sector.



**Provisioning SectorConfiguration**

Template : SectorConfiguration

ClearFill Star Sector Configuration

Sector Name(\*) Voice

Sector Number(\*) 3

Frequency Band PCS

Channel Number(\*) 875

Base Station PN Offset(\*) 11

Service Type VOICE

**Status**

Template loaded successfully

Show Debug Information (\*) indicates a mandatory field

Next Description Close

Figure 61 SectorConfiguration template step 1



Enter:

- Sector Name (usually Voice or Data)
- Sector Number (2 for Data, 3 for Voice)
- Frequency Band
- Channel Number
- Base Station PN Offset
- Service Type (Voice or Data)

Click on next to continue the setup.

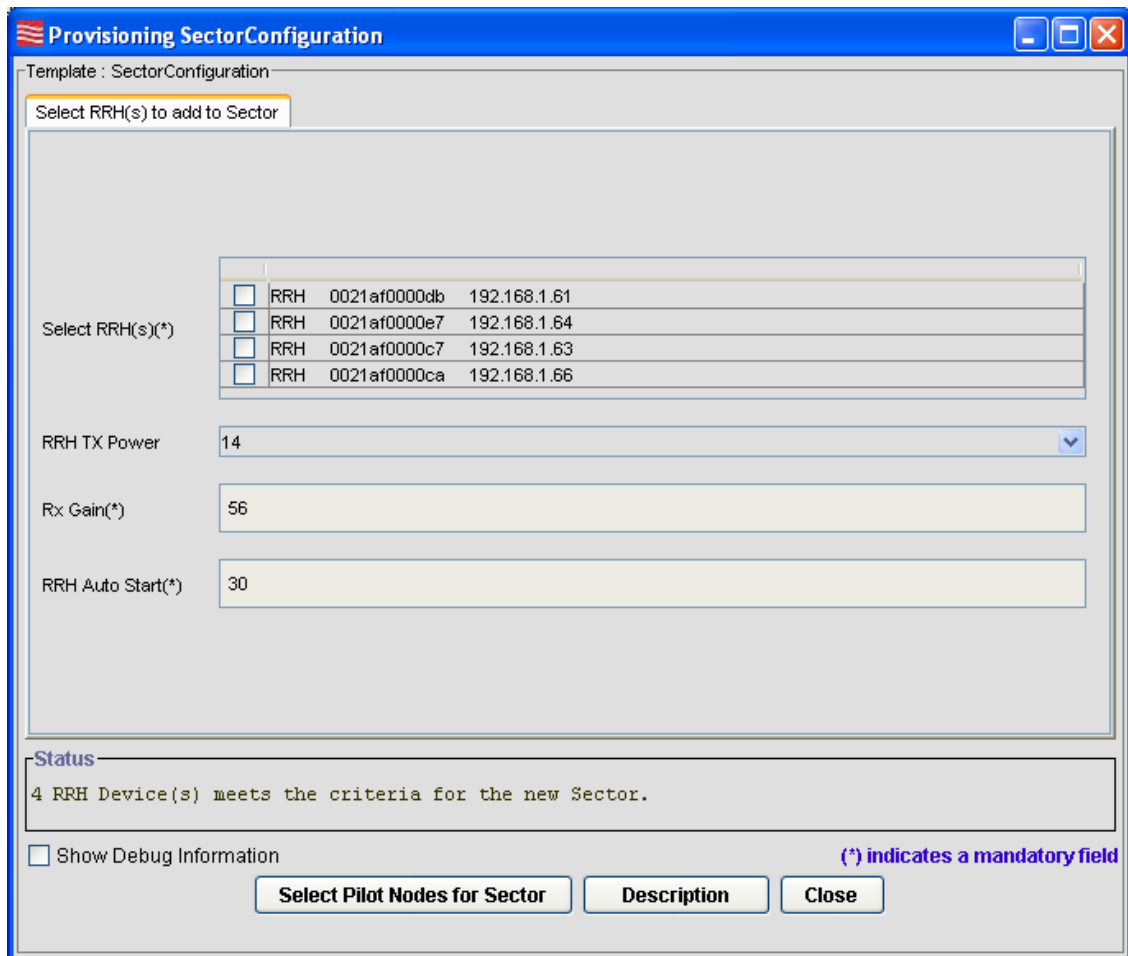
**Figure 62 SectorConfiguration template step 2**

Select

- BSI of sector
- BSI auto start

Click Next to continue setup





Template : SectorConfiguration

Select RRH(s) to add to Sector

Select RRH(s)(*)	RRH ID	IP Address
<input type="checkbox"/>	RRH 0021af0000db	192.168.1.61
<input type="checkbox"/>	RRH 0021af0000e7	192.168.1.64
<input type="checkbox"/>	RRH 0021af0000c7	192.168.1.63
<input type="checkbox"/>	RRH 0021af0000ca	192.168.1.66

RRH TX Power: 14

Rx Gain(\*): 56

RRH Auto Start(\*): 30

Status: 4 RRH Device(s) meets the criteria for the new Sector.

Show Debug Information (\*) indicates a mandatory field

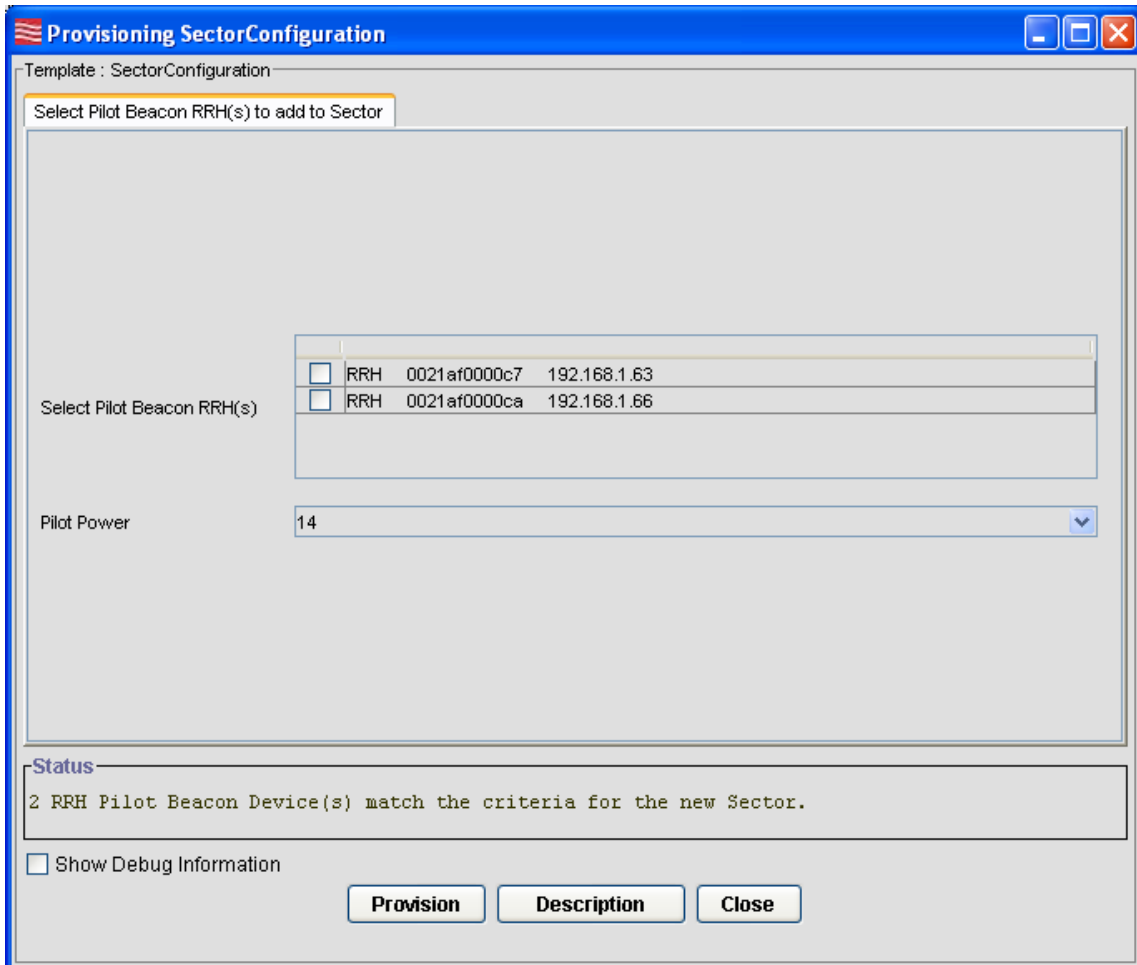
Select Pilot Nodes for Sector Description Close

**Figure 63 SectorConfiguration template step 3**

Select:

- RRHs for sector
- RRH TX Power
- RX Gain
- RRH Auto Start

A data sector configuration is finished with this step. Add Provision to get directly to step 5. When configuring a voice sector it is possible to continue with the configuration of a pilot beacon from here. Click on Select Pilot Nodes for Sector to continue with pilot beacon selection (step 4).



Template : SectorConfiguration

Select Pilot Beacon RRH(s) to add to Sector

RRH	RRH ID	IP Address
<input type="checkbox"/>	RRH 0021af0000c7	192.168.1.63
<input type="checkbox"/>	RRH 0021af0000ca	192.168.1.66

Select Pilot Beacon RRH(s)

Pilot Power: 14

Status

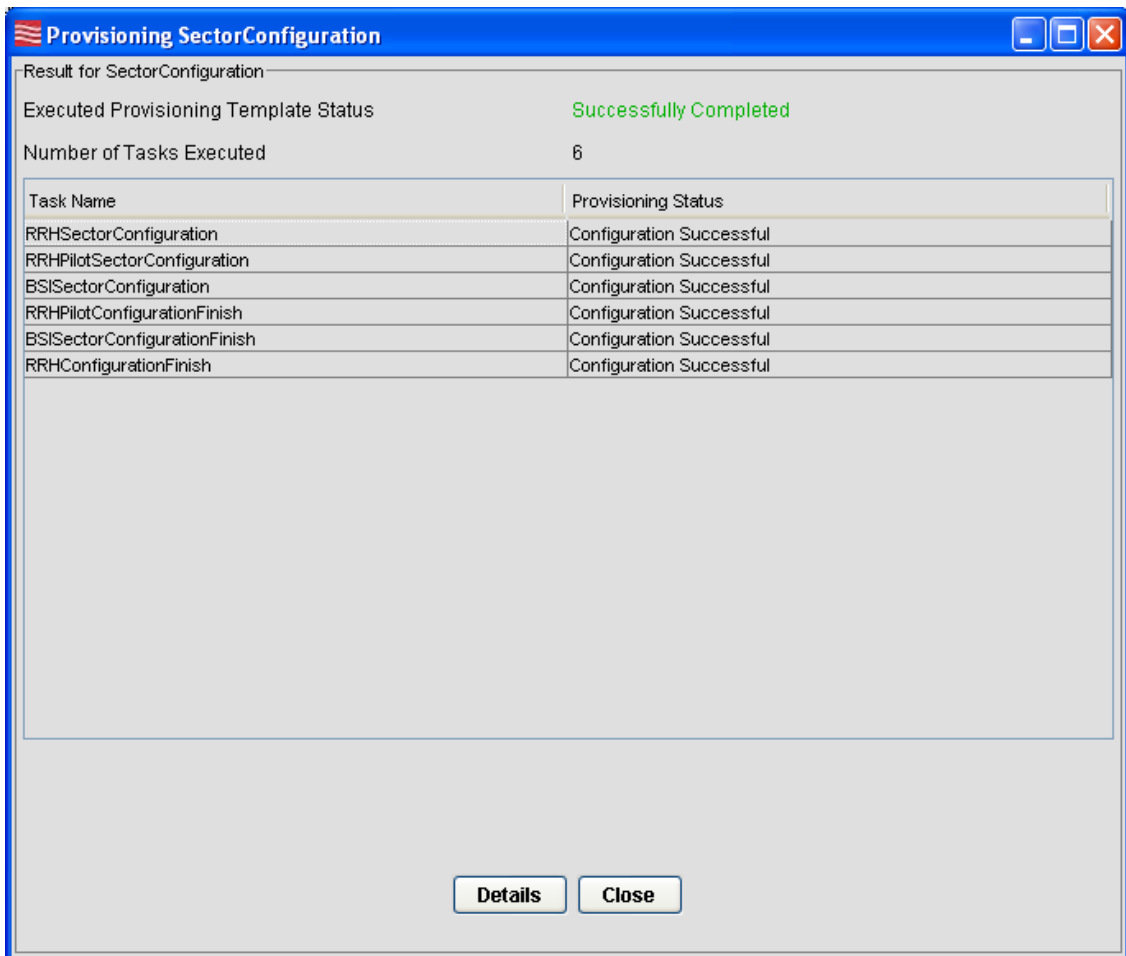
2 RRH Pilot Beacon Device(s) match the criteria for the new Sector.

Show Debug Information

**Provision** **Description** **Close**

**Figure 64 SectorConfiguration template step 4**

Select the RRH to be configured for pilot beacon use.  
Click on Provision to finish the sector configuration.

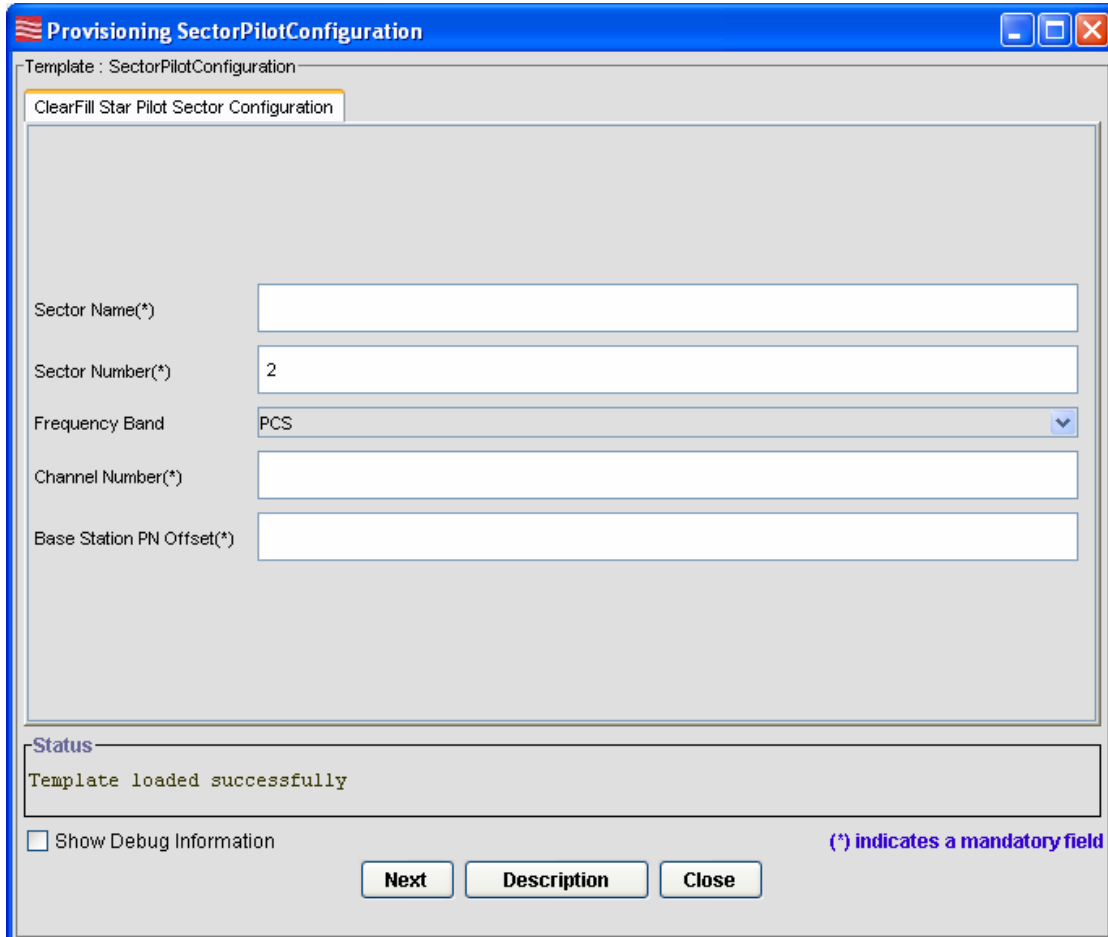


**Figure 65 SectorConfiguration template step 5**

The final screen of the sector configuration shows if the sector configuration has been executed successfully. Any failed steps are listed here.

### 5.5.3.1.6 SectorPilotConfiguration

This template is used to configure sectors that provide pilot beacon only functionality. Follow this walkthrough to configure an RRH for pilot beacon use.



Provisioning SectorPilotConfiguration

Template : SectorPilotConfiguration

ClearFill Star Pilot Sector Configuration

Sector Name(\*)

Sector Number(\*) 2

Frequency Band PCS

Channel Number(\*)

Base Station PN Offset(\*)

Status

Template loaded successfully

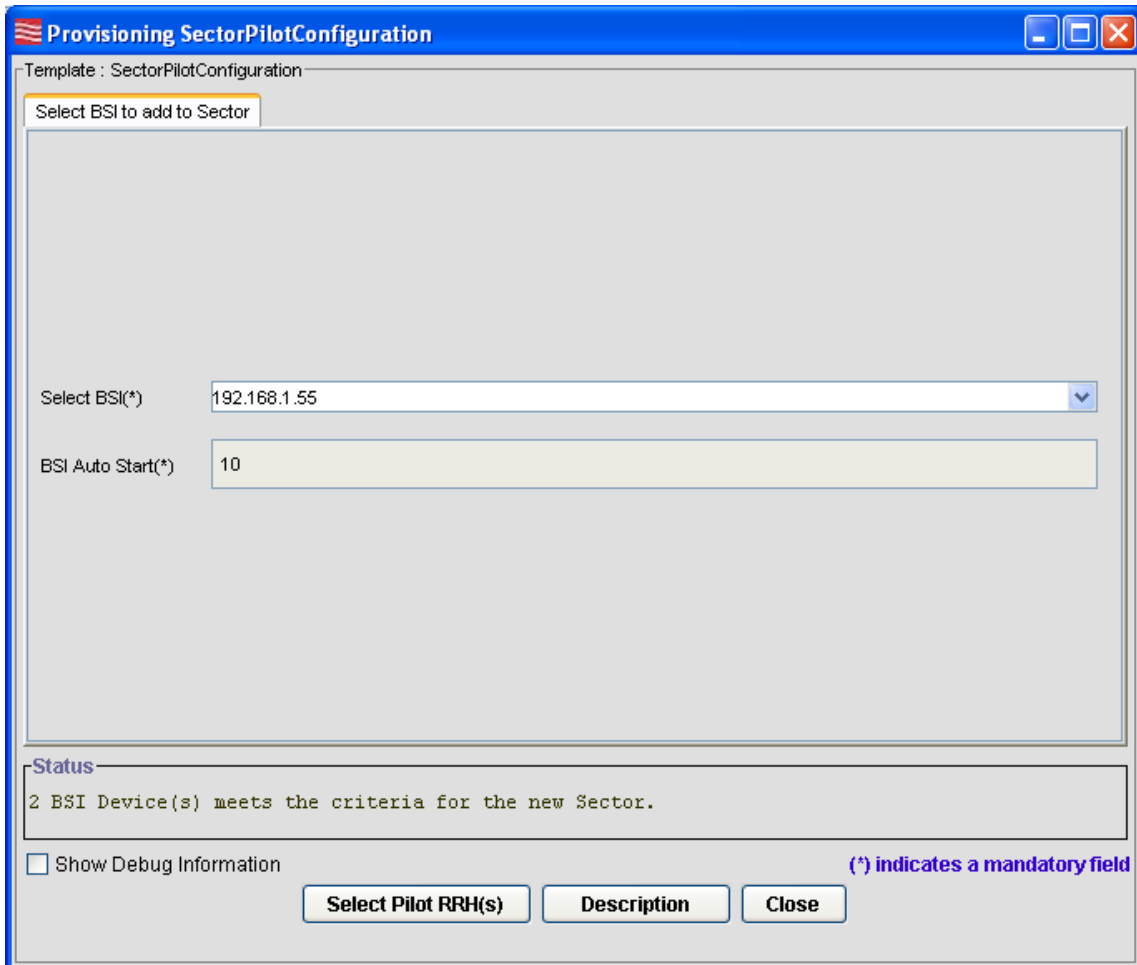
Show Debug Information (\*) indicates a mandatory field

Next Description Close

Figure 66 SectorPilotConfiguration template step 1

Step 1: Enter

- Sector Name
- Sector Number
- Frequency Band
- Channel Number
- Base Station PN Offset



Provisioning SectorPilotConfiguration

Template : SectorPilotConfiguration

Select BSI to add to Sector

Select BSI(\*) 192.168.1.55

BSI Auto Start(\*) 10

Status

2 BSI Device(s) meets the criteria for the new Sector.

Show Debug Information (\*) indicates a mandatory field

Select Pilot RRH(s) Description Close

Figure 67 SectorPilotConfiguration template step 2

Step 2:

- Select BSI for the sector
- Enter BSI Auto Start

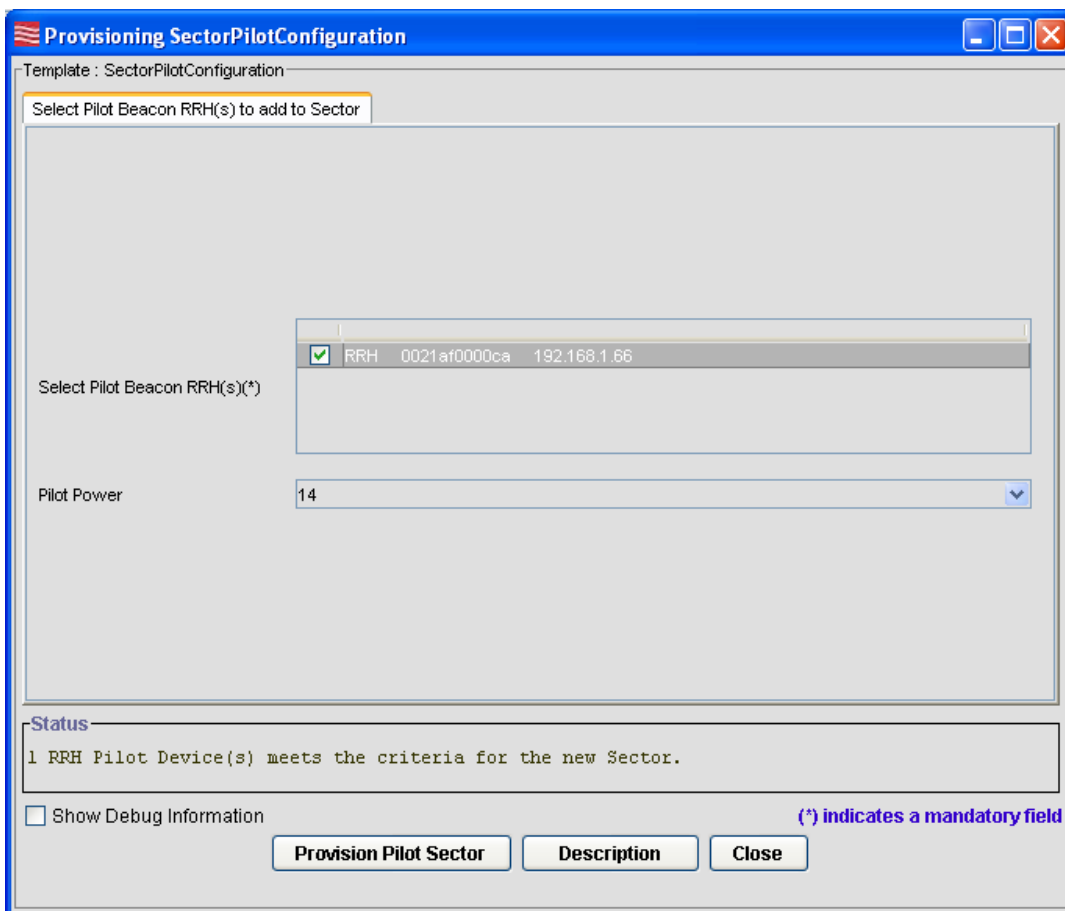


Figure 68 SectorPilotConfiguration template step 3

Step 3:

- Select Pilot Beacon RRHs.
- Click on Provision Pilot Sector to finish setup of pilot beacon.

### 5.5.3.2 Activity List

Every activity is stored in the activity list. It can be used to verify if provisioning was successful. It is possible to view results by double clicking on item and then again by double clicking on the specific task. Results can also be monitored in the Logs Window.

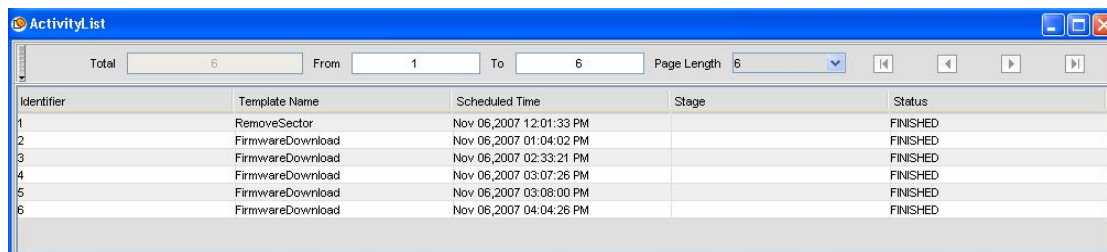


Figure 69 Activity List





## 5.5.4 Network Database

The Network Database view works in much the same way as the Network Maps view except the format which is textual instead of graphical.

The Network Maps (graphical format) are described in section 5.5.1.

Click on Application Network Database in the tree pane (left-hand side). Following sub nodes appear:

- Networks
- Nodes
- Interfaces
- Switches
- ClearFill Star BSI
- ClearFill Star RRH

The following chapters describe each of those sub nodes.

### 5.5.4.1 Networks

The Networks view shows all networks that are connected to the NMS server.

Right clicking on any network in the right-hand window brings up the network right click menu (see chapter 5.6.3).

In right-click menu it is possible to stop and restart the node discovery. The current status of the network discovery is shown in the list view as status value (see Figure 70) .

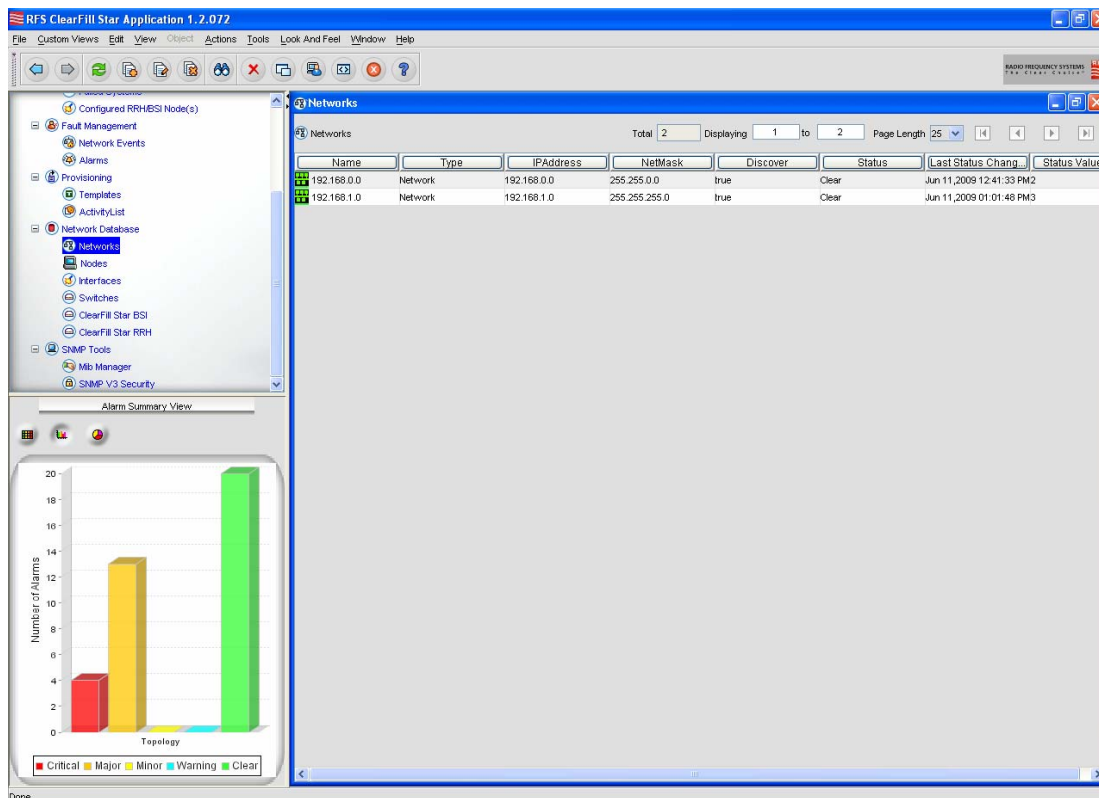


Figure 70 Network Database Network View

The meaning of each value is:

- 1 = Discovery Yet to Begin
- 2 = Discovery in Progress
- 3 = Discovery Finished
- 4 = Discovery Disabled

#### **5.5.4.2 Nodes**

This view is used for the node configuration. Nodes can be configured both in the Network Maps and in the Network Database view. Both support the configuration menus that are accessed via right click on the node to be configured.

#### **5.5.4.3 Interfaces**

All interfaces are displayed and can be managed

#### **5.5.4.4 Switches**

All switches are displayed and can be managed

#### **5.5.4.5 ClearFill Star BSI**

All BSIs are displayed and can be managed

#### **5.5.4.6 ClearFill Star RRH**

All RRHs are displayed and can be managed

### **5.5.5 SNMP Tools**

For expert mode only!

#### **5.5.5.1 MIB Manager**

For expert mode only!

#### **5.5.5.2 SNMP V3 Security**

For expert mode only!

## **5.6 Right Click Menus**

The menus to access for example configuration features are usually hidden to keep the screen from being too crowded by rarely used icons.

The device specific configuration features are displayed by right clicking on the device to configure. This is done identically in the Network Database and Network Maps view. The appearing menus are device specific.

### 5.6.1 RRH/BSI Right-Click Options

For the RRH,BSI and summing nodes, the right click menus are as follows:



**Figure 71 RRH/BSI Right Click Menu**

- **Managed Object Properties**  
This menu allows the user to edit the managed object properties.
- **Delete Object and Traces**  
This menu allows the user to delete a node's object and traces in the NMS.
- **Events And Alarms**  
Clicking on Events and Alarms shows the following screen for the node.
- **Configuration**  
This menu leads to RRH Configuration (section 5.6.3) or BSI Configuration (section 5.8), depending on what kind of device has been selected with the previous right click.
- **UnManage**  
This option allows the user to unmanage the selected node from the NMS.
- **Update Status**  
This option refreshes the selected node's status.

## 5.6.2 Switch Right-Click Menu

Right clicking on any switch shows the following menu. Each option opens its respective window.

Managed Object Properties
Delete Object and Traces
HTTP Device
Telnet to device
Interfaces
IpNetToMedia Table
Events And Alarms
Telnet to device
UnManage
Update Status

**Figure 72 Switch Right Click Menu**

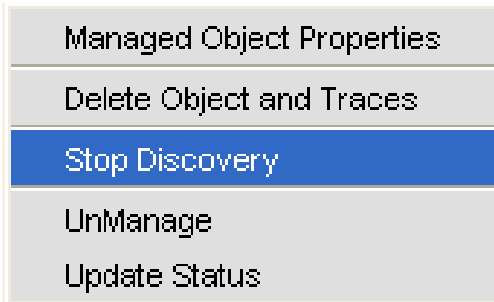
- **Managed Object Properties**  
This menu allows the user to edit the managed object properties.
- **Delete Object and Traces**  
This menu allows the user to delete a node's object and traces in the NMS.
- **HTTP Device**  
Opens an HTTP connection to the switch, the standard browser of the system is started in an extra window.
- **Telnet To Device**  
A telnet session to the switch is opened.
- **Interfaces**  
An extra window with the switch interfaces is opened.
- **IpNetToMedia Table**  
The IP Net To Media table is opened in an extra window.
- **Events and Alarms**  
Open an extra window to display all active events and alerts of this switch.
- **UnManage**  
This option allows the user to unmanage the selected node from the NMS.
- **Update Status**  
This option refreshes the selected node's status.

The Switch Status screen can be seen below. From this screen, it is possible to see which ports are active and inactive as well as their respective locations, IP addresses and their status.

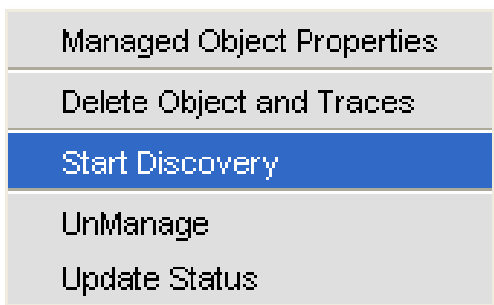
### 5.6.3 Network Right-Click Menu

In the Network application, it is possible to stop and restart the node discovery application by clicking on the Networks view in the Application Client window as seen below.

Right click on the desired network and select either 'Stop Discovery' or 'Start Discovery' in the context menu.



**Figure 73 Network right-click menu with stop option**



**Figure 74 Network right-click menu with start option**

The Discovery Status is displayed in the Network view under 'Disc Status'. The meaning of each value is:

- 1 = Discovery Yet to Begin
- 2 = Discovery in Progress
- 3 = Discovery Finished
- 4 = Discovery Disabled

## 5.7 RRH Configuration

The RRH Configuration screen is accessed via the right click menu. Click on an RRH unit in Network Maps or Network Database view and select Configuration->RRH Configuration.

Follow this walkthrough to setup an RRH unit.

The upper half of the configuration screen shows the IP address, the running status (online or offline) and the MAC address of the device to be configured. Press Read Device to update the screen by reading the device again.

There are also two error indicators:

- RF packet loss
- SYNC

The frame should be green to indicate flawless operation. The frame turns red in case of an error condition.

The lower half of the configuration screen is divided into four tabs, the general configuration, the pilot beacon configuration, the sector configuration and the status.

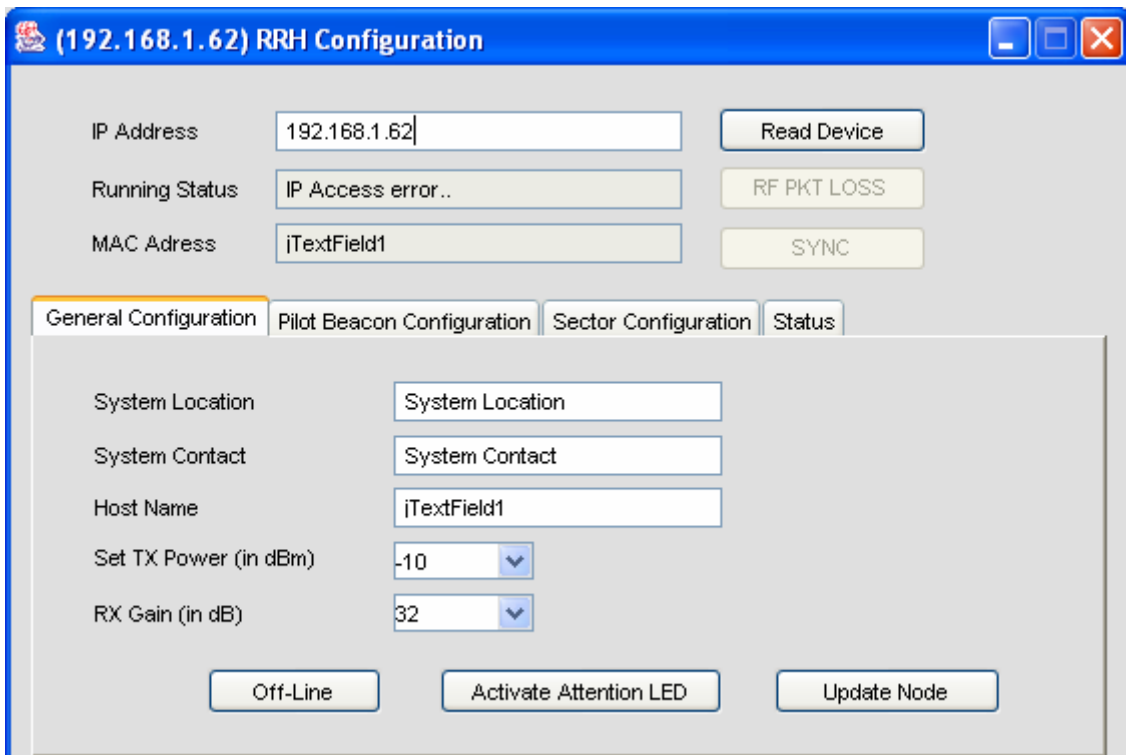
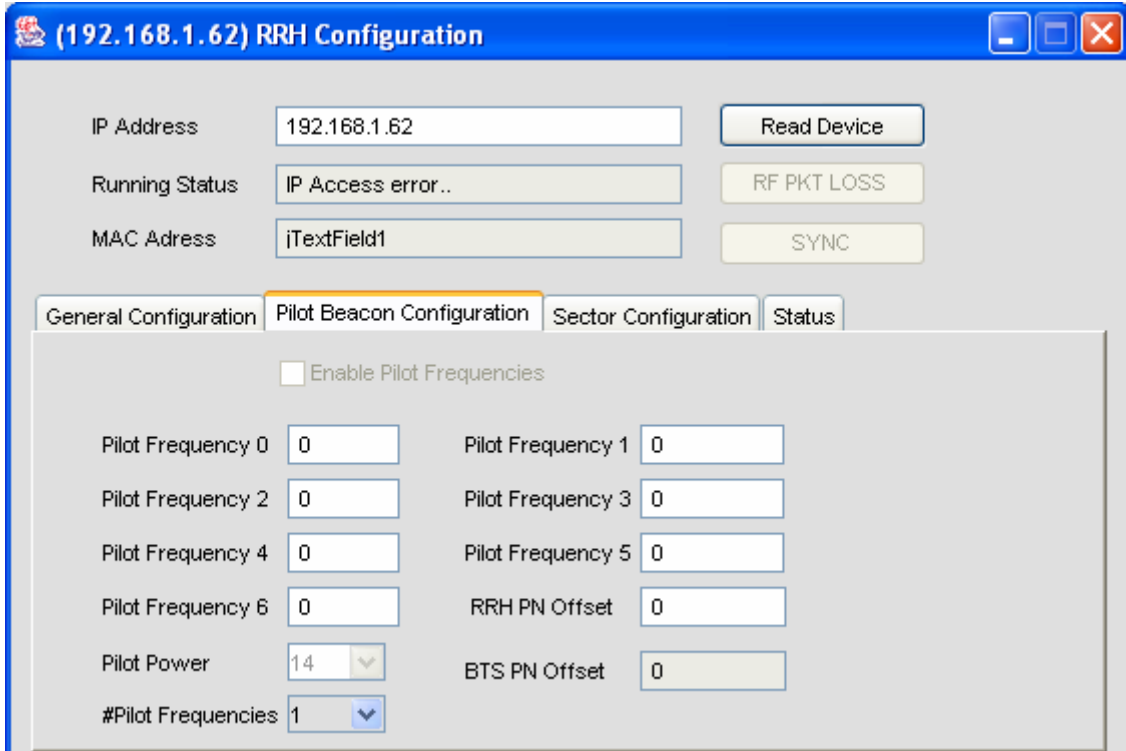


Figure 75 RRH General Configuration Tab

In the general configuration tab it is possible to set:

- System location
- System contact
- Host Name
- TX power (dBm)
- RX Gain



(192.168.1.62) RRH Configuration

IP Address: 192.168.1.62    Read Device

Running Status: IP Access error..    RF PKT LOSS

MAC Address: jTextField1    SYNC

General Configuration | **Pilot Beacon Configuration** | Sector Configuration | Status

Enable Pilot Frequencies

Pilot Frequency 0: 0    Pilot Frequency 1: 0

Pilot Frequency 2: 0    Pilot Frequency 3: 0

Pilot Frequency 4: 0    Pilot Frequency 5: 0

Pilot Frequency 6: 0    RRH PN Offset: 0

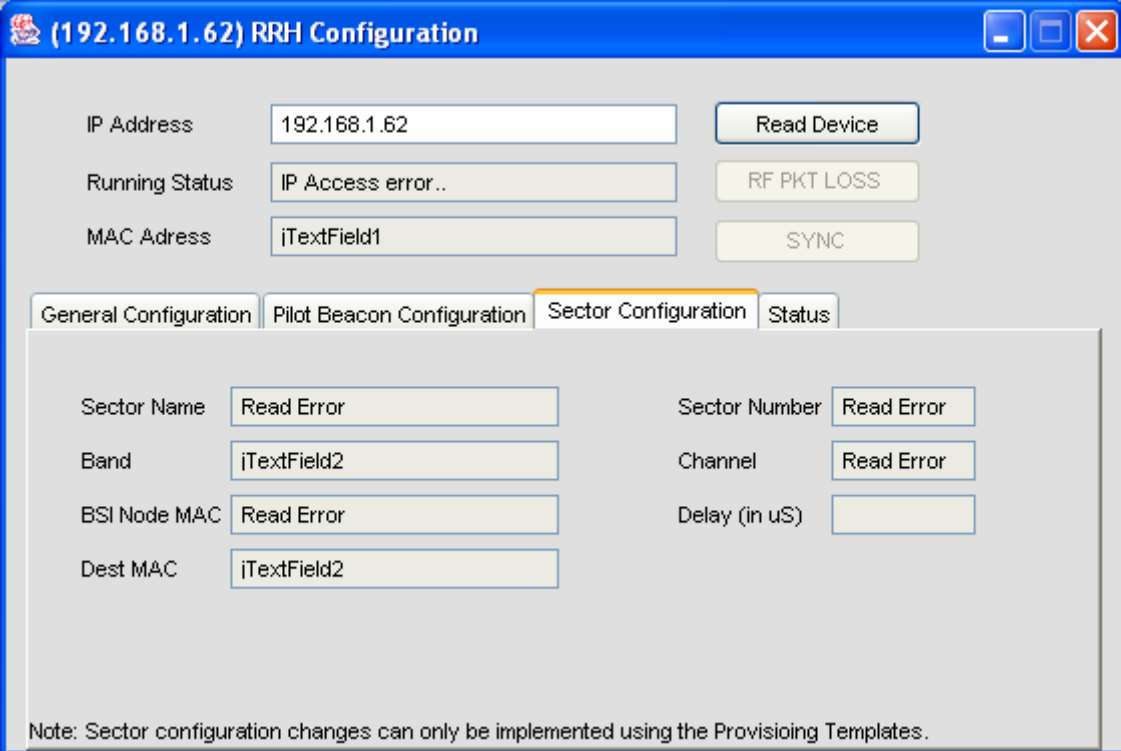
Pilot Power: 14    BTS PN Offset: 0

#Pilot Frequencies: 1

**Figure 76 RRH Pilot Beacon Configuration Tab**

In the pilot beacon setup menu it is possible to set:

- The number of pilot frequencies (use the drop down menu in the lower left corner)
- 7 pilot frequency windows, depending on the number that has been selected in the drop down menu these are grayed out (unused) or white (settable)
- RRH PN Offset
- BTS PN Offset



(192.168.1.62) RRH Configuration

IP Address: 192.168.1.62    Read Device

Running Status: IP Access error..    RF PKT LOSS

MAC Address: iTextField1    SYNC

General Configuration | Pilot Beacon Configuration | **Sector Configuration** | Status

Sector Name: Read Error    Sector Number: Read Error

Band: iTextField2    Channel: Read Error

BSI Node MAC: Read Error    Delay (in uS):

Dest MAC: iTextField2

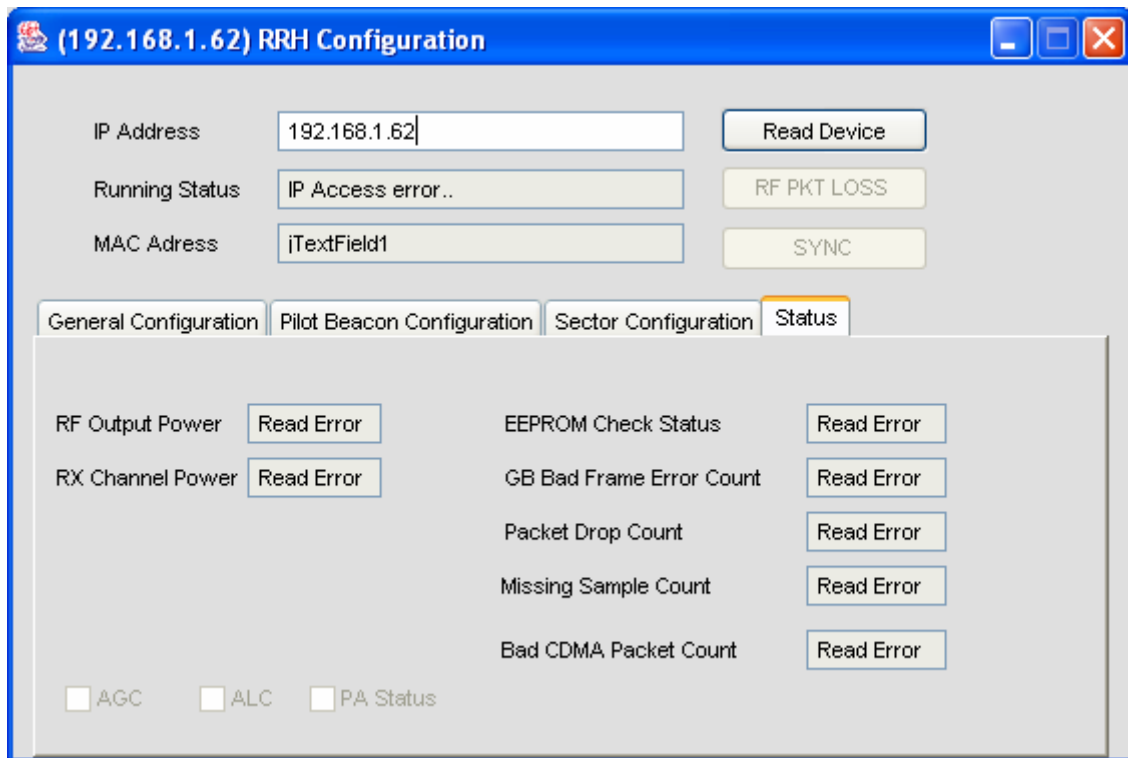
Note: Sector configuration changes can only be implemented using the Provisioning Templates.

**Figure 77 RRH Sector Configuration Tab**

The sector configuration tab consists of:

- Sector Name
- Band
- BSI Node MAC
- Dest MAC
- Sector Number
- Channel
- Delay in micro seconds





(192.168.1.62) RRH Configuration

IP Address: 192.168.1.62

Running Status: IP Access error..

MAC Address: |TextField1

Buttons: Read Device, RF PKT LOSS, SYNC

Tabs: General Configuration, Pilot Beacon Configuration, Sector Configuration, **Status**

RF Output Power: Read Error

RX Channel Power: Read Error

EEPROM Check Status: Read Error

GB Bad Frame Error Count: Read Error

Packet Drop Count: Read Error

Missing Sample Count: Read Error

Bad CDMA Packet Count: Read Error

AGC  ALC  PA Status

**Figure 78 RRH Status Tab**

The status menu consists of:

- RF Output Power
- RX Channel Power
- EEPROM Check Status
- GP Bad Frame Error Count
- Packet Drop Count
- Missing Sample Count
- Bad CDMA Packet Count

## 5.8 BSI Configuration

The BSI Configuration screen is accessed via the right click menu. Click on a BSI unit in Network Maps or Network Database view and select Configuration->BSI Configuration.

Follow this walk through to setup a BSI unit.

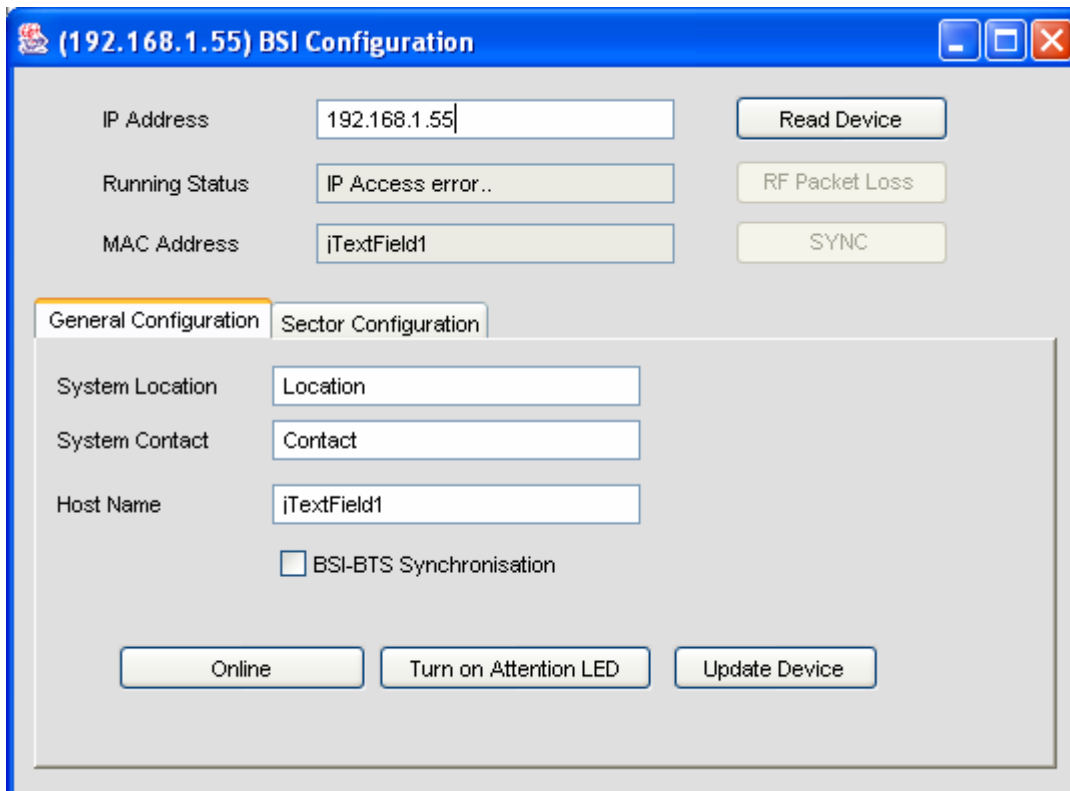
The upper half of the configuration screen shows the IP address, the running status (online or offline) and the MAC address of the device to be configured. Press Read Device to update the screen by reading the device again.

There are also two error indicators:

- RF packet loss
- SYNC

The frame should be green to indicate flawless operation. The frame turns red in case of an error condition.

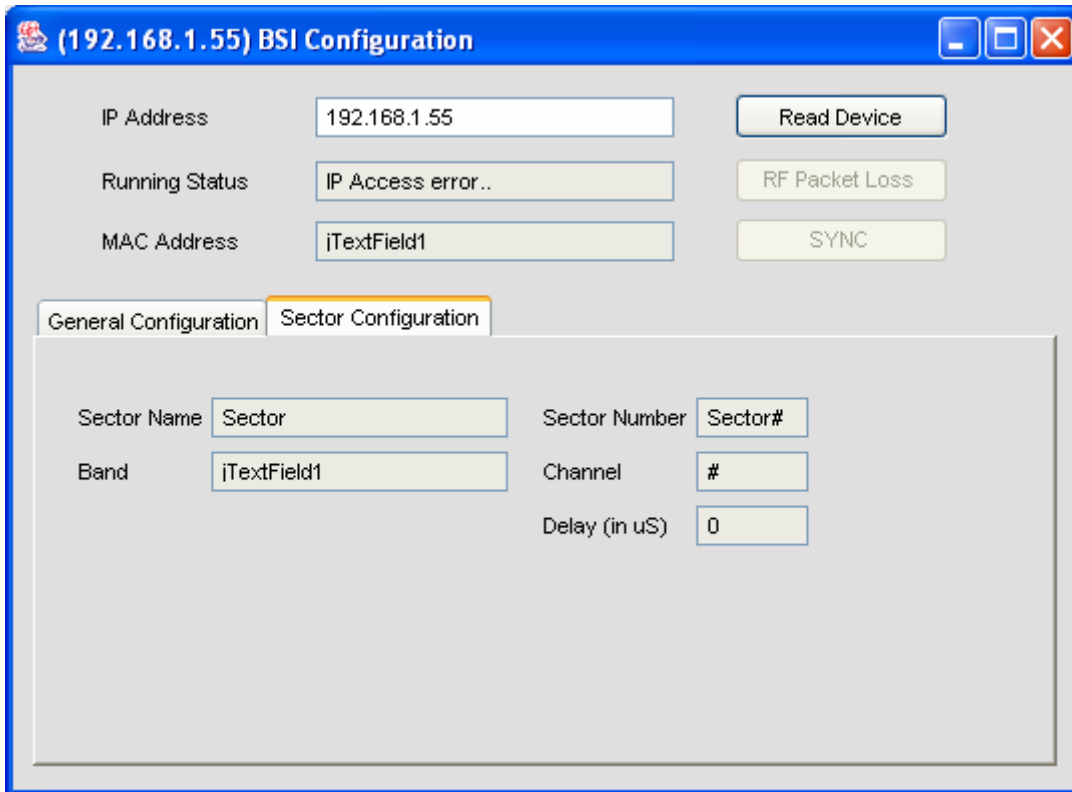
The lower half of the configuration screen is divided into two tabs, the general configuration and the sector configuration.



**Figure 79 BSI Configuration General Tab**

In the General Configuration Tab it is possible to set:

- The system location
- System contact
- Host name



The screenshot shows a software window titled "(192.168.1.55) BSI Configuration". It has a blue title bar with standard window controls. The main area is divided into two tabs: "General Configuration" and "Sector Configuration", with the latter being active. In the General Configuration section, there are three rows: "IP Address" with a text field containing "192.168.1.55" and a "Read Device" button; "Running Status" with a text field containing "IP Access error.." and an "RF Packet Loss" button; and "MAC Address" with a text field containing "jTextField1" and a "SYNC" button. The Sector Configuration section contains five rows: "Sector Name" with a text field containing "Sector" and "Sector Number" with a text field containing "Sector#"; "Band" with a text field containing "jTextField1" and "Channel" with a text field containing "#"; and "Delay (in uS)" with a text field containing "0".

**Figure 80 BSI Configuration Sector Tab**

In the sector configuration tab it is possible to see the current setting of

- Sector name
- Sector number
- Band
- Channel
- Delay in micro seconds

### 5.8.1 Fault Management

All events (traps) and alarms in a network are shown in the Fault Management applications. These sub nodes are accessible when fault management application has been selected in the tree view.

- Network Events
- Alarms

These options are available for both views:

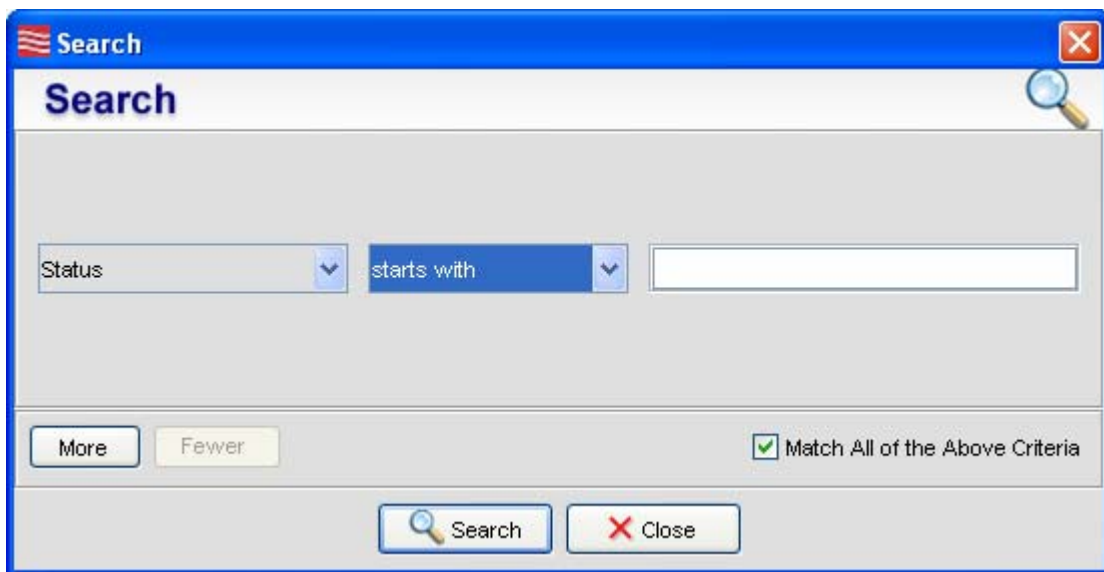
- Search for Events
- Save Events
- Export Events
- Print Events

### 5.8.1.1.1 Event search options

The search option is designed to look for a particular event within the Network Event list. The search operation is performed in the database and is not restricted to the events that are currently visible in the Application Client panel.

To search for an event do one of the following actions while in Network Events view:

- From Edit menu, choose Search.
- From the toolbar, click Find button.
- Press Ctrl+F.



**Figure 81 Search Window**

After opening the search window there is one line with a criteria to be defined visible. Two drop down menus are available to select a column to search through (Status, Source, Date or Message) and the criteria to look for. In the text box the user has to enter a search pattern to look for.

After this search pattern has been configured another search criteria can be added by clicking the More button.

The Fewer button removes a previously added search criteria.

In the lower right corner there is the option: 'Match any of the following'.

If the checkbox is activated any messages that match any of the previously defined criteria are listed as the search result.

If the checkbox is not set the search results includes only messages that match ALL defined search criteria.

The search results are displayed in the right hand window that contained all network events before. To show all events again (not just the search results) click the 'Show all' button in the upper right corner.

### 5.8.1.2 Event save option

The save option is used to save the current range of events displayed in the Event Viewer. The events are saved by following one of these steps:

- Perform any of the following procedures.
- From Actions menu, choose Save to File.
- In the toolbar, click Save.
- Press Ctrl+I.
- The Properties dialog box is displayed.
- Enter the file name in File Name field.
- Click Save File.

A status message is displayed.

### 5.8.1.3 Export Event

The Export Events option is used to save the Event Custom View data as a CSV (comma-separated values) file on the ClearFill®Star NMS server. An Option is provided to export the entire Custom View data or only the data that is currently displayed in the Custom View.

To export the events follow these steps:

- From Actions menu, choose Export Events. The Export Data dialog box is displayed.
- Choose the desired option from the radio buttons Export Entire Custom View Data or Export Displayed Data.
- Enter the file name in File name field.
- Click Export. A status message is displayed.

The exported custom view data is saved in the home directory.

### 5.8.1.4 Print Event

The Print option can be used to print the current range of events displayed in the Event Viewer.

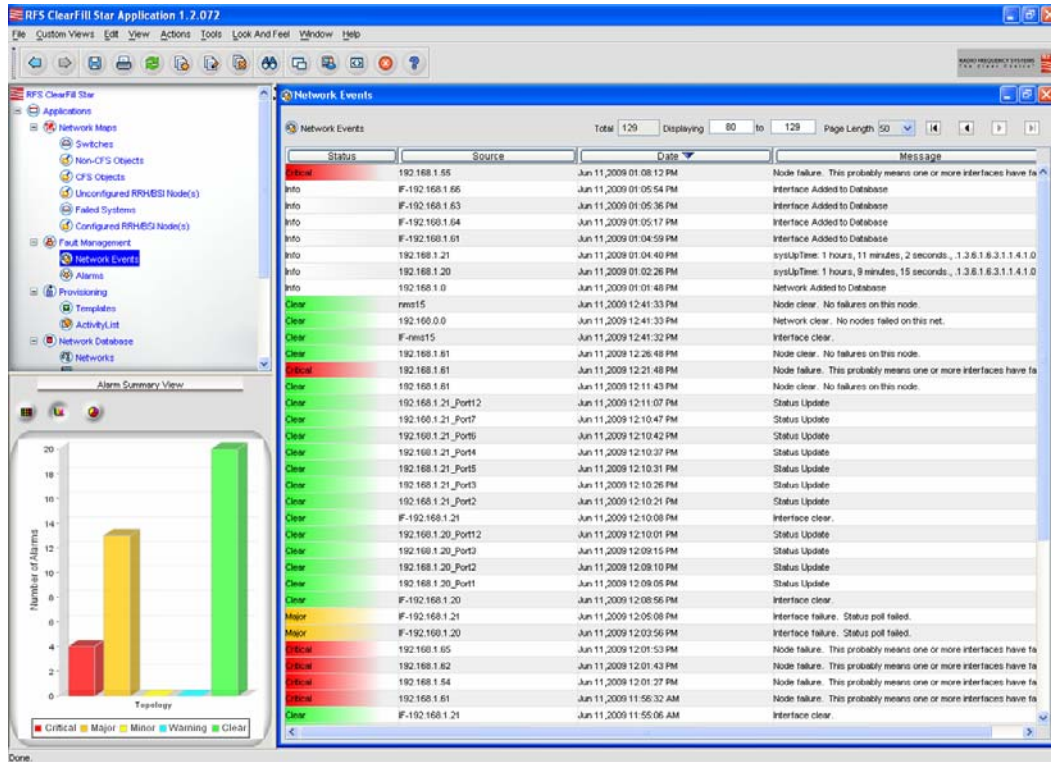
To print events follow these steps

- Perform any of the following procedures.
- From Actions menu, choose Print.
- In the toolbar, click Print button.
- Press Ctrl+P.

The current range of events in the Event Viewer is printed.

### 5.8.1.4.1 Network Event View

Click Network Events display node in the tree. The network events are displayed in an Event Viewer on the display panel, see screen shot below.



**Figure 82 Event Viewer**

All events are displayed in the Event Viewer. Each row in the table depicts an event. The events can be sorted by column (Status, Source, Date or Message) in ascending or descending alphabetical order. Click on the column title to be used for sorting. An arrow appears that shows if the order is ascending (arrow turned upwards) or descending (arrow turned downwards).

To view more event details do one of the following actions in the Network Events view:

- Click a row in the table and from View menu, choose Details.
- Right-click a row in the table and choose Details.
- Click a row in the table and press Alt+D.
- Double-click a row in the table



#### **5.8.1.4.2 Alarms View**

In the alarms view a history of alarms is listed.

To view only related alarms for only one device you may change to the Event viewer and proceed with these steps:

- Open the Event Viewer.
- Click a row whereby you select an event.
- Perform any of the following procedures.
- From View menu, choose Alarms.
- Right-click the row and choose Alarms.
- Press Ctrl+L.

Alarm Viewer with only the alarms related to the selected event is displayed.



## 6 Configuration Management

### 6.1 Introduction

The ClearFill®Star Application Client is the graphical user interface for the configuration management it is running on the ClearFill®Star NMS server or it is running remotely connected to the NMS server.

The configuration management is done with the ClearFill®Star Application Client. It is used to configure the elements of the ClearFill®Star network.  
See chapter 5 for an overview of this tool.

### 6.2 Change settings and system parameters

All ClearFill®Star network elements are configured with the ClearFill®Star Application Client. The procedure is usually to use a template assistant to configure a sector. The sector configuration creates logical groups of network elements.  
The element specific fine tuning is done after the sector configuration for each individual network element.

#### 6.2.1 Sector configuration

The sector configuration should be done before any device specific setting is performed. The sector configuration is defining the logical groups of ClearFill®Star elements that work with the same carrier.

The sector configuration is done with a provisioning template. There is a step by step walk through in section 5.5.3.1.5. Please follow this template for every sector to be configured once.

In case of any uncompleted sectorization, failure, or cancellation by user, please remove all elements (see section 5.5.3.1.4 Remove Sector).

#### 6.2.2 RRH

The following RRH functions are controlled via NMS Server:

##### 6.2.2.1 Setting of TX Power

The TX Power is set in the RRH Configuration menu. It is described in section 5.6.1.

##### 6.2.2.2 Setting of Rx Gain

The RX Gain is set in the RRH Configuration menu. It is described in section 5.6.1.

Note: End-to-End gain in uplink is RX-Gain + 5dB.

##### 6.2.2.3 Setting of channel allocation

The setting is done automatically by VLAN selection.

##### 6.2.2.4 Summing function activation and deactivation

The setting is done automatically, no user interaction is necessary.



### 6.2.2.5 Pilot beacon generation and set-up

The pilot beacon is configured in the RRH Configuration menu. It is described in section 5.6.1.

### 6.2.2.6 Switching between CELL and PCS band

The switching between CELL and PCS band is done only once during initial sector configuration. The sector configuration is described in chapter 6.2.1.

To change the band from CELL to PCS or vice versa the sector has to be cleared by using the template described in section 5.5.3.1.4. Afterwards the sector configuration has to be redone with updated band values.

### 6.2.2.7 Assignment to a BTS sector

The Assignment of RRHs to a BSI is done during the sector configuration. The sector configuration is described in chapter 6.2.1.

To change the relation between RRHs and BSI the sector has to be cleared by using the template described in section 5.5.3.1.4. Afterwards the sector configuration has to be redone with updated BTS sector.

### 6.2.2.8 Beacon

The beacon functionality is configurable within the RRH configuration menu. It is described in section 5.6.1.

### 6.2.2.9 Power-off of RRH

The RRH is supplied by the PoE functionality. The switch off can be done via the GES.

This is done by following procedure:

- Use ClearFill®Star Application Client.
- Change to the menu Application->Network Maps->Switches.
- Right click on the switch that is supplying the RRH with power.
- Click on HTTP device. The browser will open automatically, showing the HTTP menu of the switch.
- Login with:
  - Username : admin
  - Password: admin
- Click in the left hand menu on PoE.
- Click in the opening sub menu on PoE Configuration. An overview of all ports of the GES opens.
- Look for port number that is supplying RRH with power.
- Select first drop down list in the relating row.
- Select Disable.
- Click Apply button (bottom of screen), power is turned off now.
- Select drop down menu again.
- Select Enable.
- Click Apply button again, power is turned on again, RRH reboots.

### 6.2.3 GES

The GES is configurable over an own HTTP menu. This menu can be reached by simply opening a browser (e.g. Microsoft Internet Explorer) and entering an “http://” followed by the IP address of the GES.

It is also accessible by using the ClearFill®Star Application Client. And change to the menu Application->Network Maps->Switches. Right click on the switch symbol and select (HTTP device). The browser will open automatically, showing the HTTP menu of the switch.

To set up the GES for ClearFill®Star operation please follow the initial installation guide as described in section 4.4 Installation Gigabit Ethernet Switch (GES). The use of other settings is not advisable.

### 6.2.4 BSI

The following BSI functions are controlled via NMS:

#### 6.2.4.1 Channel allocation

The channel allocation is done only once during initial sector configuration. The sector configuration is described in chapter 6.2.1.

To change the channel allocation the sector has to be cleared by using the template described in section 5.5.3.1.4. Afterwards the sector configuration has to be redone with updated channel data.

#### 6.2.4.2 Assignment to a BTS sector (VLAN setting)

The assignment to a BTS sector is done only once during initial sector configuration. The sector configuration is described in chapter 6.2.1.

To change the assignment to a BTS sector the sector has to be cleared by using the template described in section 5.5.3.1.4. Afterwards the sector configuration has to be redone with updated channel data.

#### 6.2.4.3 Summing function activation and deactivation

The setting is done automatically, no user interaction is necessary.

#### 6.2.4.4 Switching between CELL and PCS band

The switching between CELL and PCS band is done only once during initial sector configuration. The sector configuration is described in chapter 6.2.1.

To change the band from CELL to PCS or vice versa the sector has to be cleared by using the template described in section 5.5.3.1.4. Afterwards the sector configuration has to be redone with updated band values.

#### 6.2.4.5 Switch off the BSI.

The BSI is power supplied by the PoE functionality or an external power supply. When it is supplied over an external power supply the switch off has to be done manually by disconnecting (or switching off) the external power source.

When the BSI is supplied by the PoE functionality the switch off can be done via the GES. This is done by following procedure:

- Use ClearFill®Star Application Client.
- Change to the menu Application->Network Maps->Switches.
- Right click on the switch that is supplying the BSI with power.
- Click on HTTP device. The browser will open automatically, showing the HTTP menu of the switch.
- Login with:
  - Username : admin
  - Password: admin
- Click in the left hand menu on PoE.
- Click in the opening sub menu on PoE Configuration. An overview of all ports of the GES opens.
- Look for port number that is supplying BSI with power.
- Select first drop down list in the relating row.
- Select Disable.
- Click Apply button (bottom of screen), power is turned off now.
- Select drop down menu again.
- Select Enable.
- Click Apply button again, power is turned on, BSI reboots.

## 7 System Supervision

### 7.1 Introduction

The system supervision is done by the NMS Server. It stores all events and alarms that are detected within the ClearFill@Star network.

### 7.2 Supervision GUI

The ClearFill@Star Application Client is the graphical user interface for the system supervision. See chapter 5 for an overview of this tool. See chapter 5.8.1 for a detailed explanation of the fault management mechanisms.

### 7.3 Alarms and faults structure

Alarms are classified by severity. The severity classes are also associated with a color. The alarm severity is in ascending order:

- Clear
- Warning
- Minor
- Major
- Critical

### 7.4 Alarm description and their possible causes



This section describes the monitor- and control functionality of BSI and RRH.

### 7.4.1 BSI

The following functions are monitored and communicated to the NMS:

- Ambient temperature inside BSI (An alarm is generated when threshold is exceeded.)
- Status of synchronization to BTS (An alarm is generated when synchronization is lost.)
- Received RF power level in downlink (input signal within selected channel bandwidth)
- RF Packet loss
- Running status
- IP connectivity

Local LED indication of BSI status (see Figure 41):

LED	Description of Function	Status	
		OK	Failure
1	Green State LED A blinking state indicates that the processor is operational. The LED also flashes in response to the NMS flash attention LEDs command (used to identify a particular node in the network). A static state (ON or OFF) indicates that the processor is no longer operating correctly, a power-cycle is required to recover from this state.	Blinking / Flash	Off / On (Static)
2	Amber Warning LED. This LED flashes in response to the NMS flash attention LEDs command (used to identify a particular node in the network).	Flash	N/A
3	Red Error LED. Indicates a processor boot failure. When the node is powered-up this LED blinks and then remains off. If the processor fails to successfully execute it's internal boot sequence on power-up the LED remains on.	Off	On / Blinking
4	Green Link Status LED. When the node has successfully negotiated 1000BASE-T full duplex mode this LED is on. LED off state indicates that the negotiating failed, or the link is down. The node only supports 1000BASE-T operation.	On	Off
5	Orange Link Transmit LED. This LED is on when the node is transmitting Ethernet data.	Blinking / On / Off	N/A

**Table 10 LED indications at RRH**

## 7.4.2 RRH

The following functions are monitored and communicated to the NMS:

- DL output power level (composite).
- Ambient temperature inside RRH (Threshold is configurable via NMS. An alarm is generated when threshold is exceeded.)
- Power consumption of RRH (Threshold is configurable via NMS. An alarm is generated when threshold is exceeded. This information is provided to the NMS by the GES (PoE functionality).)
- Status of synchronization to BSI
- UL input power level & Protective circuits
- RF Packet loss
- Running status
- IP connectivity

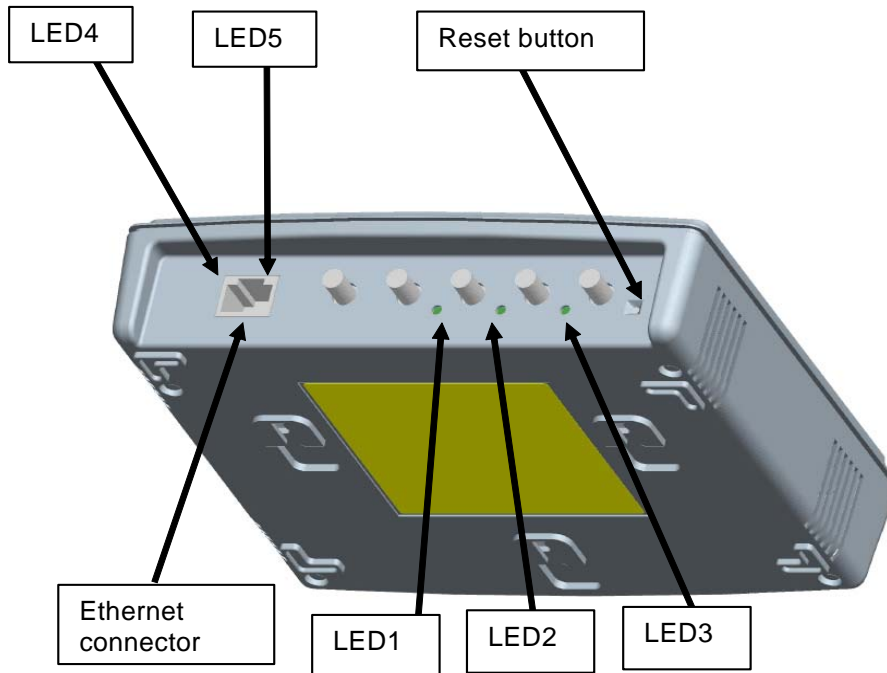
The following information are reported to the NMS

- Interferer protection active / inactive
- AGC active / inactive (The threshold of the AGC is defined by the gain setting of the RRH.)
- Input signal power level within selected CDMA channel
- Data reception status (signalizes that the RRH receives Ethernet packets from GES).

Locally LED indication of RRH status (see Figure 41):

LED	Description of Function	Status	
		OK	Failure
1	Green State LED A blinking state indicates that the processor is operational. This LED also flashes in response to the NMS flash attention LEDs command (used to identify a particular node in the network). A static state (ON or OFF) indicates that the processor is no longer operating correctly, a power-cycle is required to recover from this state.	Blinking / Flash	Off / On (Static)
2	Amber Warning LED. This LED flashes in response to the NMS flash attention LEDs command (used to identify a particular node in the network).	Flash	N/A
3	Red Error LED. Indicates a processor boot failure. When the node is powered-up this LED blinks and then remains off. If the processor fails to successfully execute it's internal boot sequence on power-up the LED remains on.	Off	On / Blinking
4	Green Link Status LED. When the node has successfully negotiated 1000BASE-T full duplex mode this LED is on. LED off state indicates that the negotiating failed, or the link is down. The node only supports 1000BASE-T operation.	On	Off
5	Orange Link Transmit LED. This LED illuminates when the node is transmitting Ethernet data.	Blinking / On / Off	N/A

**Table 11 LED indication at BSI**



**Figure 83 Schematic illustration of local RRH interfaces**

## **7.5 Alarm management (graphics, analysis etc.)**

In preparation

## **7.6 External alarm routing**

In preparation



## 8 Remote Management and Supervision

When starting the ClearFill Star Client, the login window appears.

The user is asked to enter a User ID and Password to log in to the system.

Username: root

Password: public

And click "Connect"



There is also an option to login remotely, that option is described in section 7.



**Figure 84 Advanced Login Screen**

### Remote login

To login remotely to the application client, it is necessary to specify the IP address of the host. Instead of 'localhost', enter the IP address of the NMS server. It may be necessary to specify a different port address. The default port number is '9090'.

Possible implementations for the remote management are:

- Dial up modem
- Data packet modem
- External alarm connection

The setup of those connections has to be done by the local network administrator.

## 9 Operational used cases/Maintenance

### 9.1 Introduction

This chapter provides instructions for the most common use cases. It also provides instructions on how to contact RFS in case of hardware defects.

### 9.2 Swap faulty devices

Please contact RFS in case of broken hardware. The procedure for contacting RFS is described in section RFS Maintenance Services. The following swap procedures assume that a new or repaired device is already available to be swapped.

#### 9.2.1 Swap RRH

Swapping procedure for an RRH:

1. Disconnect old RRH from GES.
2. Remove old RRH from wall mounting.
3. Write down MAC address of new RRH and update it in your local setup documentation.
4. Attach new RRH to wall.
5. Connect RRH to GES at same port that the old RRH was connected to.
6. Start ClearFill Star Application Client.
7. Run template AddClearFillObj (see section 5.5.3.1.1) to add the RRH to the network database.
8. Delete sector of old RRH with template RemoveSector (see section 5.5.3.1.4).
9. Reconfigure sector by running template SectorConfiguration (see section 5.5.3.1.5).
10. Fine tune RRH by using the RRH configuration menu (see section 6.2.2).

#### 9.2.2 Swap GES

Before the GES is swapped write down all the parameters of the old GES (as long as they are still accessible).

Swapping procedure:

1. Disconnect all cables from the old GES.
2. Connect all cables to the same ports as before at the new GES.
3. As soon as the GES is powered enter the switch menu (see section 4.2) and change the default IP address (192.168.1.1) to the address that was previously used by the old GES. (Change to the IP menu on the left hand side, Change the IP address and click to apply).
4. Configure VLAN, STP and SNMP settings as described in section 4.2..
5. Click to Reboot menu on the left hand side and click to "Save and Reboot".

### 9.2.3 Swap BSI

Swapping procedure for a BSI:

1. Disconnect all cables from old BSI.
2. Remove old BSI from rack.
3. Write down MAC address of new BSI and update it in your local setup documentation.
4. Put new BSI into the rack.
5. Connect all cables that were connected to the old BSI to the new BSI. Use exactly the same ports as before. Start ClearFill Star Application Client.
6. Run template AddClearFillObj (see section 5.5.3.1.1) to add the BSI to the network database.
7. Delete sector of old with template RemoveSector (see section 5.5.3.1.4).
8. Reconfigure sector by running template SectorConfiguration (see section 5.5.3.1.5).

### 9.2.4 Swap NMS

Swap procedure:

1. Shutdown old NMS server.
2. Unplug all cables from old NMS server.
3. Replace server in rack with new NMS server.
4. Connect all cables to the new server to the same ports they were connected to in the old server.
5. Start new server.
6. Start Application Client (see section 5.3.3).
7. Run discovery procedure (see section 5.3.2).

### 9.3 Add RRH

Adding procedure for an RRH:

1. Write down MAC address of new RRH and update it in your local setup documentation.
2. Attach new RRH to wall.
3. Connect RRH to a free port at GES.
4. Start ClearFill Star Application Client.
5. Run template AddClearFillObj (see section 5.5.3.1.1) to add the RRH to the network database.
6. If the RRH is supposed to be added to an existing sector: Delete sector with template RemoveSector (see section 5.5.3.1.4).
7. Reconfigure sector by running template SectorConfiguration (see section 5.5.3.1.5), include the new RRH in the list of devices for the sector.
8. Fine tune RRH by using the RRH configuration menu (see section 6.2.2).

### 9.4 Move RRH

If an RRH is moved locally to improve coverage, no IP parameters have to be changed. But it might be necessary to adjust the TX power and the RX Gain might have to get adjusted. This is done via the RRH configuration menu. See section 6.2.2.

## 9.5 Change RRH sector allocation

A sector allocation cannot be changed. The only way to change it is to delete the existing sector and configure a new sector.

Changing procedure for the sector allocation of an RRH:

1. Start ClearFill Star Application Client.
2. Delete old sector with template RemoveSector (see section 5.5.3.1.4).
3. Reconfigure sector by running template SectorConfiguration (see section 5.5.3.1.5).

## 9.6 Reset RRH and BSI

BSIs that are power supplied over an external power supply have to be manually reset by disconnecting (or switching off) the external power source.

The BSIs and the RRHs that are power supplied over the PoE functionality can be reset via the GES. This is done by following procedure:

- Use ClearFill®Star Application Client.
- Change to the menu Application->Network Maps->Switches.
- Right click on the switch that is supplying the BSI with power.
- Click on HTTP device. The browser will open automatically, showing the HTTP menu of the switch.
- Login with:
  - Username : admin
  - Password: admin
- Click in the left hand menu on PoE.
- Click in the opening sub menu on PoE Configuration. An overview of all ports of the GES opens.
- Look for port number that is supplying BS/RRHI with power.
- Select first drop down list in the relating row.
- Select Disable.
- Click on Apply button (bottom of screen), power is turned off now
- Select drop down menu again.
- Select Enable.
- Click Apply button again, power is turned back on, BSI/RRH reboots.

## 9.7 Maintenance

### 9.7.1 Introduction

The RFS product line comprises all necessary products to design and build a complete end to end solution for providing RF coverage and best Quality of Service to confined areas as buildings and tunnels. Partly this portfolio consists of active elements like ClearFill®Star system.

The following chapters describe the maintenance services (also called after sales services) defined to support the customer in the operation and maintenance of RFS Solutions.

### 9.7.2 Firmware Update

New firmware will be available on the RFS Webpage under:

[www.RFSWorld.com/](http://www.RFSWorld.com/)... (in preparation)

Please check regularly the availability of new firmware for your products. In case, load it down to a memory stick and copy it to the NMS Server.

#### 9.7.2.1 Firmware Update for GES

In preparation

#### 9.7.2.2 Firmware Update for RHH

In preparation

#### 9.7.2.3 Firmware Update for BSI

In preparation



## 9.8 Warranty

All active (as well as passive) products of the RFS portfolio are coming with a standard warranty period of 12 months. This warranty can be extended by paying an additional warranty fee.

### 9.8.1 RFS Maintenance Services

Note: The following chapters 9.8.1 – 9.8.4 are general information only. For Alcatel-Lucent customers:

To obtain technical support, documentation and training or to submit feedback:

The Alcatel-Lucent Online Customer Support (OLCS) website:

<http://support.alcatel-lucent.com> provides access to technical support, related documentation, and related training and feedback tools. The site also provides account registration for new users.

#### 9.8.1.1 Maintenance services within warranty:

The following after sales services are part of the standard warranty:

- Welcome Center
- Repair
- SW maintenance releases

#### 9.8.1.2 Extended warranty services:

Extended warranty services are services which are not covered under the “standard” warranty and therefore have to be purchased separately.

Typical extended warranty / after sales services:

- Help Desk (standard local working hours)
- Inventory and Spare Part Management
- Remote Support (via remote access to the active element to element manager)
- On-site support



## 9.8.2 Welcome Center

### 9.8.2.1 Introduction

Purpose of the Welcome Center is to provide a regional single interface to the customer to initiate any type of service request. Furthermore, the Welcome Center is in the position to track the customer service demand and give feedback to the customer regarding the status of their request.

The following maintenance services have to be initiated via the Welcome Center:

- Initiate product repair
- Trigger/initiate technical support

For both types of service demands, the Welcome Center is to register the customer request and forwards it to the appropriate team.

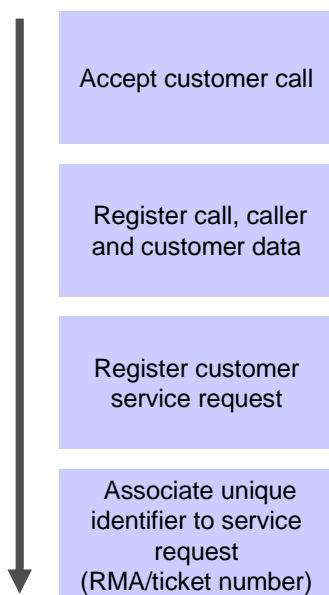
### 9.8.2.2 Workflow

The repair process will be triggered by the RFS regional Welcome Center. The customer sends the faulty unit to the RFS regional repair Center.

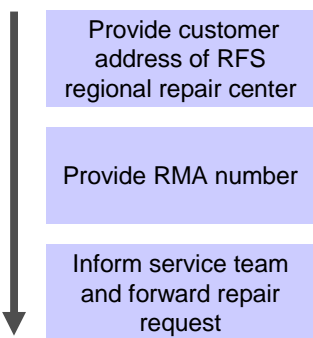
Each repair of a faulty unit is registered and tracked under a unique identifier called RMA (Return Merchandise Authorization).

RFS target is to provide to the customer a repair service with a turn around time of 30 days as standard.

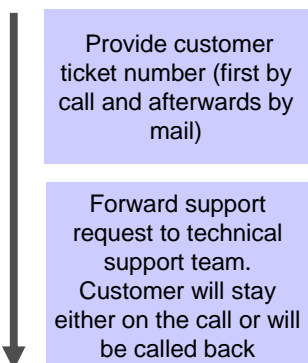
The following pictures describe the general workflow for Welcome Center activities.



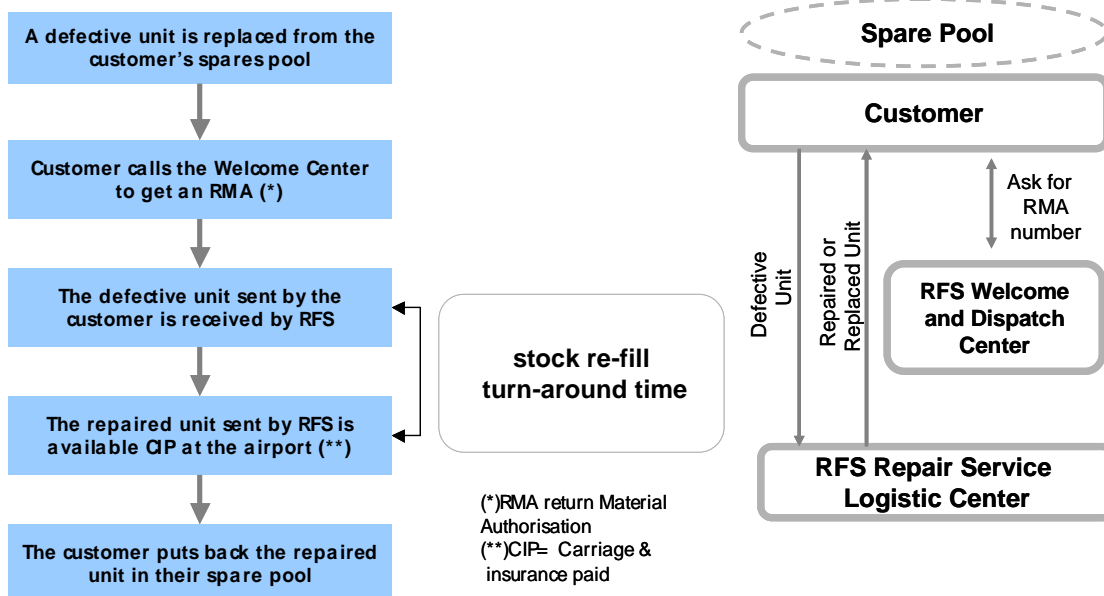
**Figure 85 Register Service Request from Customer**



**Figure 86 Initiate Product Repair (to Customer)**



**Figure 87 initiate or trigger technical support**



**Figure 88 RFS repair process**





### 9.8.3 Technical Support / Help Desk

Any technical support required by the customer is registered via the Welcome Center as first step. The Welcome Center then forwards the support request to the technical support team.

In general, technical support is not part of the basic warranty.

### 9.8.4 Escalation levels

The following table shows the definition of different support levels for the product. The more complex the problem to be solved the higher the level.

#### Technical support hierarchy / escalation:

##### Level 1 technical support / system operation

With customer/mobile operator

##### Level 2 technical support

With customer/integrator (call center, support organization trained by RFS)

##### Level 3 technical support

RFS Regional technical support, Application engineering, technical consulting, and field support

##### Level 4 technical support

RFS central technical support, global competence center (Germany)

### 9.8.5 SW Maintenance

The following section defines the process to provide SW maintenance to the customer. This covers the software for the NMS as well as the SW running within the RRH and BSI (firmware).

To offer new NMS SW release to the customer the NMS HW platform and the NMS SW are two separate saleable items.

For the RRH and BSI, new SW features will be offered as “features” bringing new functionality to the system.

According the RFS software policy the following definitions apply:

**Release upgrades:** New release incl. new features; **not part of standard warranty**

**Release updates:** Mainly bug and failure fixing; **free of charge and part of standard warranty**

The customer will be informed of new SW release updates via email to customers with notification of a new release update ready for download.

On special request release updates can be distributed via CD but this will not be for free.

#### **Distribution of release update**

- Release update will be uploaded to RFS xtranet with release notes and installation instructions
- Customer will download release update from xtranet and install according to installation instructions

## 10 System Specifications and Technical Data

### 10.1 RF Specification of ClearFill®Star System

#### 10.1.1 General Specification

Frequency range	PCS 1900    UL: 1850 – 1910 MHz DL: 1930 – 1990 MHz  CELL 800    UL: 824 – 849 MHz DL: 869 – 894 MHz  <i>The channel frequencies are on a 30 kHz spacing for Cellular band and a 50 kHz spacing for PCS band</i>
Supported IF bandwidth	1.25 MHz (UL and DL)
Frequency plan / Channel allocation	C.S0002
RF impedance	50 Ohm

#### 10.1.2 Downlink

The following specifications for DL refer to the system configuration shown in Figure 89. All specifications apply for CELL and PCS frequency bands.

##### 10.1.2.1 ClearFill®Star System DL Interfaces

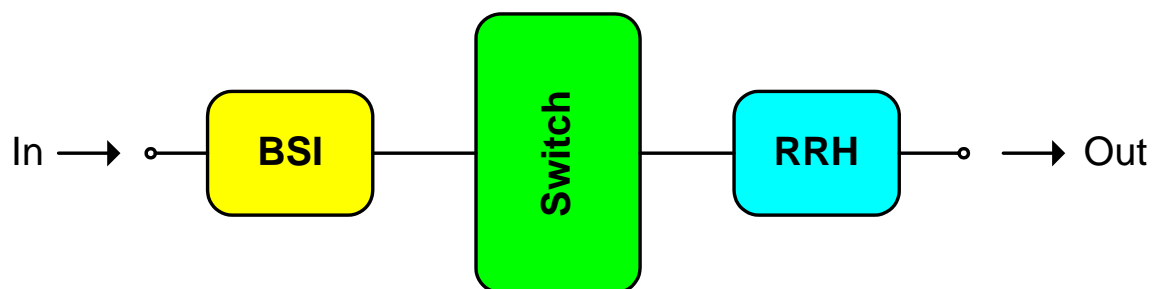


Figure 89 DL System Configuration for Specification

### 10.1.2.1.1 Downlink Parameter Specification

Input power level	-57dBm nominal, composite
Output power level	+14.5 dBm $\pm$ 1.5dB composite at max loading over full RF bandwidth
Manual setting of output power level	+14.5 dBm to -9.5 dBm in 1 dB steps @ nominal input the attenuation is realized in the RRH
ACPR	>45dBm @ 30kHz
Output power level at extreme Temperature	14.5 dBm $\pm$ 2.5dB
Nominal system gain	PCS: 71 dB $\pm$ 1dB Cellular: 71dB $\pm$ 1dB
Noise figure	<13dB @ max. gain <17dB @ min gain
Return Loss	>9dB @ BSI >7dB @ RRH
EVM at antenna port	< 10%

**Table 12 Downlink Parameter Specifications**

### 10.1.3 Uplink

#### 10.1.3.1 ClearFill®Star1 System UL Interfaces

The following description for UL refers to a system configuration shown in Figure 90.

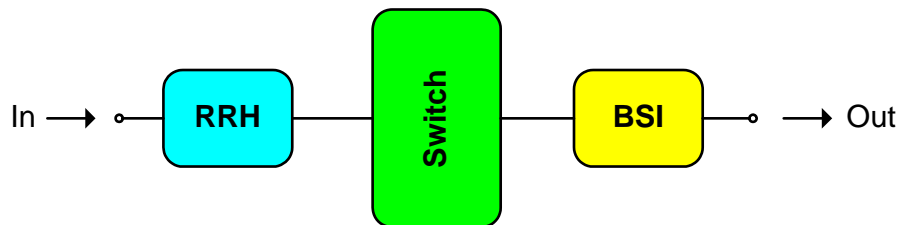


Figure 90 UL System Configuration for Specification

### 10.1.3.1.1 Uplink Parameter Specification (Linear Operation)

		CELL800 / PCS1900
Input power level range	-65 to -90 dBm at maximum gain -49 to -80 dBm at minimum gain	
Nominal gain	61 dB for input power level range	
Manual gain setting	61 dB to 37 dB in 1 dB steps (the gain setting has to be performed in the RRH)	
Output power level @ max. Input and max. gain	-4 dBm $\pm$ 1.5 dB	<i>max. composite output power level independent to number of connected RRHs. Assumed PAR=10dB</i>
Output power level at extreme temperature	-4 dBm $\pm$ 2.5 dB	
EVM at BSI output port	< 10 %	
Noise figure	< 12 dB at room temperature and 61 dB gain, < 23 dB at room temperature and 37 dB gain  <i>The system noise figure will increase as more RRHs are added to a sector.</i>	
ACPR	> 45 dBc @ 30kHz	
Return Loss	> 9 dB @ all RF connectors	
In-band noise floor and spurious without input signal	<-38.5 dBm / 1.25MHz @ maximum gain <-51.5 dBm / 1.25MHz @ minimum gain	

**Table 13 Uplink Parameter Specification**

## 10.2 System elements data sheets



The following section describes the performance of the sub-system responsible for the transport of the mobile communication link between BTS and handheld. Furthermore, it describes the interaction with the other sub-systems.

### 10.2.1 POI

#### 10.2.1.1 RF Interface

POI Type	TX BTS output power level	POI-BTS interface	POI BSI interface
CFS-POIS1S2-19 1900, BTS port 1x simplex, BSI Port 2x simplex	0 dBm	2 RF ports (1x Rx, 1x Tx)	4 RF ports (1x Channel1Tx, 1x Channel1Rx, 1x Channel2 Tx, 1x Channel2 Rx)
CFS-POIS1S2-819 850/1900, BTS port 1x simplex, BSI Port 2x simplex	0 dBm	2 RF ports (1x Rx, 1x Tx)	4 RF ports (1x Channel1Tx, 1x Channel1Rx, 1x Channel2 Tx, 1x Channel2 Rx)
Other POIs on request			

**Table 14 BTS and POI configurations**

In case the TX output power level of the BTS is too high to be handled by the POI with an SMA connector, an additional attenuator is available to be switched between the BTS and the POI to decrease the input power level for the POI.

#### 10.2.1.2 Mechanical specifications

These mechanical specifications apply for all types of POI:

Sealing Class	IP20
Mounting & fixings	bench top or rack mounted
Grounding	via Ethernet cable
Housing (max. dimensions)	19 inch rack slide in, 1 HU Type Depth: 211mm , max. 300mm
Cooling	Convection cooled, no fans
Color of front panel	White, RAL 9010

## 10.2.2 Simplex Twin BSI

### 10.2.2.1 RF Interface

Interface to POI	<p>8 simplex RF ports, type SMA female:</p> <p>Rx1/2-CELL</p> <p>RX1/2-PCS</p> <p>Tx1/2-CELL</p> <p>Tx1/2-PCS</p> <p>Functions: DL input, UL output Position: on the front panel</p>
------------------	--

### 10.2.2.2 Power supply interface

external DC supply	<p>The external DC supply fulfils all regulatory requirements. The external power supply port is at the back plane.</p> <p>48VDC (connector 48VDC, 2.1x5.5x11mm female barrel, wired Center positive)</p>
PoE	Via Power over Ethernet connector: RJ-45
Grounding	via Ethernet or DC connector
Power consumption	<14 W per BSI

### 10.2.2.3 Mechanical Specifications

Sealing Class	IP20
Mounting & fixings	bench top or rack mounted
Grounding	via Ethernet cable or DC connector (dependant on voltage supply)
Housing (max. dimensions)	19 inch rack slide in, 1 HU Type Depth: 211mm, max. 300mm
Cooling	Convection cooled, no fans
Color of front panel	White, RAL 9010



### 10.2.3 RRH

#### 10.2.3.1 RF Interface

Antenna interface at RRH	one duplexed RF port, type SMA female cable length < 3 m (10 ft) Functions: DL output, UL input
--------------------------	---

#### 10.2.3.2 Power supply interface

PoE	via Ethernet cable (POE)
Grounding	via Ethernet cable
Power consumption	<14 W

#### 10.2.3.3 Mechanical specification

Sealing Class	IP20
Mounting & fixings	walls, ceilings in any kind of polarization
Grounding	via Ethernet cable
Housing (max. dimensions)	length: 181mm height: 44mm depth: 166mm
Weight	600g
Color	White, RAL 9010

### 10.2.4 GES

#### 10.2.4.1 Power supply interface

Power supply interface	115/230 VAC $\pm$ 10% 50Hz $\pm$ 5% auto-ranging connector type 3-pole IEC
Grounding	Grounding to the GES shall be provided via mains cable

### 10.2.4.2 Mechanical Specification

Sealing Class	IP20
Mounting & fixings	bench top or rack mounted
Grounding	via AC mains
Housing (max. dimensions)	19 inch rack slide in, 1 HU Type Depth: 211mm, max. 300mm
Cooling	Convection or fan cooled
Color of front panel	White, RAL 9010

## 10.3 Environmental Conditions

### 10.3.1 Operations

- Operating temperature: 0°C to +40°C
- Operating environment: relative humidity 0% to 90%, non-condensing
- Mechanical operation: ETSI EN 300 019-1-3, class 3.2 1

### 10.3.2 Transportation & Storage

- Storage temperature: -20°C to +75°C
- Transportation: ETSI EN 300 019-2-2, class 2.3 (public transportation)



## 11 Conformance Statements

### 11.1 United States

#### 11.1.1 Introduction

The following statements are the product conformance statements that apply to the Clear Fill Star product when deployed in the United States.

#### 11.1.2 Federal Communications Commission (FCC)

Important! Changes or modifications made to this equipment not expressly approved by RFS may void the FCC authorization to operate this equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- (1) this device may not cause harmful interference, and
- (2) this device must accept any interference received, including interference that may cause undesired operation.

#### 11.1.3 FCC Part 15 Class A

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at the user's expense.

#### 11.1.4 RF approval

This equipment complies with Part 2, Subpart J - Equipment Authorization Procedures, of the FCC Rules.

The Clear Fill Star system complies with Part 22 – Public Mobile Services, Subpart H – Cellular Radiotelephone Services and with Part 24 - Personal Communications Services, Subpart E - Broadband PCS.

#### 11.1.5 IEC product safety conformance

The Clear Fill Star system is Safety Certified IEC 60950-1 (ed.2) by CB-Scheme.

Should the local Authority Having Jurisdiction (AHJ) require prior or additional verification of this Certification, a Product Certificate of Compliance can be obtained from the specific Certification Body by the Business/Product Unit Applicant for the product or by contacting RFS customer services.

Any modifications to this equipment are not permitted without review and official written authorization from the specific Certification Body. Unauthorized changes may violate the Product Safety Certification. Modifications or changes authorized by official CN/CNN are assumed to have received prior approval from this Lab.





### 11.1.6 Indoor applications

This equipment is intended for installation in restricted access locations where access is controlled or where access can only be gained by service personnel with a key or tool. Access to this equipment is restricted to qualified service personnel only.

### 11.1.7 Antenna exposure

Antenna installations for the Clear Fill Star product shall be performed in accordance with all applicable manufacturer's recommendations, and national laws and regulations. To ensure correct antenna installation, the antenna installer shall perform all necessary calculations and/or field measurements to evaluate compliance with applicable national laws or regulations regarding exposure to electromagnetic fields. The supplier of radio equipment, the supplier of antenna equipment and the integrator and builder of the site must provide sufficient information so that the limits of the exclusion zones can be determined. Any changes to the antenna or other equipment in the transmit path may require re-evaluation of the exposures to electromagnetic fields.

Pursuant to 47 CFR Part 1, Subpart I, subject to the provisions of section 1.1307, all installations must be evaluated for requirements contained in Table 1, "Limits for maximum permissible exposure," in section 1.1310.

### 11.1.8 Radiofrequency radiation exposure Information

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance of 20 cm between the radiator and your body.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

### 11.1.9 Packaging collection and recovery requirements

Countries, states, localities, or other jurisdictions may require that systems be established for the return and/or collection of packaging waste from the consumer, or other end user, or from the waste stream. Additionally, reuse, recovery, and/or recycling targets for the return and/or collection of the packaging waste may be established.

For more information regarding collection and recovery of packaging and packaging waste within specific jurisdictions, please contact the RFS customer services.

### 11.1.10 Recycling / take-back / disposal of products and batteries

Electronic products and batteries bearing or referencing the symbols shown below shall be collected and treated at the end of their useful life, in compliance with applicable European Union and other local legislation. They shall not be disposed of as part of unsorted municipal waste. Due to materials that may be contained in the product and batteries, such as heavy metals, the environment and human health may be negatively impacted as a result of inappropriate disposal.





Moreover, in compliance with legal requirements and contractual agreements, where applicable, RFS will offer to provide for the collection and treatment of RFS products bearing the logo at the end of their useful life, or products displaced by RFS equipment offers. For information regarding take-back, recycling, or disposal of equipment by RFS or for equipment take-back requests contact RFS customer services.

## 11.2 Canada

### 11.2.1 Introduction

The statements that follow are the product conformance statements that apply to the ClearFill®Star product when deployed in Canada.

### 11.2.2 Industry Canada (IC)

Important! Changes or modifications made to this equipment not expressly approved by RFS may void the IC authorization to operate this equipment.

This device complies with ICES-003 / RSS-210 of Industry Canada. Operation is subject to the following two conditions:

- (1) this device may not cause harmful interference, and
- (2) this device must accept any interference received, including interference that may cause undesired operation.

### 11.2.3 Indoor applications

This equipment is intended for installation in restricted access locations where access is controlled or where access can only be gained by service personnel with a key or tool. Access to this equipment is restricted to qualified service personnel only.

### 11.2.4 Packaging collection and recovery requirements

Countries, states, localities, or other jurisdictions may require that systems be established for the return and/or collection of packaging waste from the consumer, or other end user, or from the waste stream. Additionally, reuse, recovery, and/or recycling targets for the return and/or collection of the packaging waste may be established.

For more information regarding collection and recovery of packaging and packaging waste within specific jurisdictions, please contact the RFS customer services.

### 11.2.5 Recycling / take-back / disposal of products and batteries

Electronic products and batteries bearing or referencing the symbols shown below shall be collected and treated at the end of their useful life, in compliance with applicable European Union and other local legislation. They shall not be disposed of as part of unsorted municipal waste. Due to materials that may be contained in the product and batteries, such as heavy

metals, the environment and human health may be negatively impacted as a result of inappropriate disposal.

Moreover, in compliance with legal requirements and contractual agreements, where applicable,

RFS will offer to provide for the collection and treatment of RFS products bearing the logo at the end of their useful life, or products displaced by RFS equipment offers. For information regarding take-back, recycling, or disposal of equipment by RFS or for equipment take-back requests contact RFS customer services.



## 12 Appendix

### 12.1 Abbreviations:

+	the + sign attached to BSI or RRH indicates that this unit is running in summing modus
ALC	Automatic Level Control
BER	Basic Encoding Rules
BSI	Base Station Interface
BSI+	Summing BSI node
BTS	Base Transceiver Station
CDMA	Code Division Multiple Access
CFS1	ClearFill@Star-CDMA
ClearFill@	Product Brand Name
ClearFill@Star	Product Brand Name
ClearFill@Star	ClearFill@Star
Community names (or Strings)	Essentially passwords
CW	Continuous sinusoidal Wave (un-modulated signal)
DAS	Distributed Antenna System
DHCP	Dynamic Host Control Protocol
DL	Downlink (from BTS to mobile)
DNS	Domain Name Service, Ethernet service to associate clear names to IP addresses
DVT	Design Verification and Test
EMS	Element Management System
ETSI	European Telecommunications Standards Institute
GES	Gigabit Ethernet Switch
ICMP	Internet Control Message Protocol
ICO	Microsoft Icon
IETF	Internet Engineering Task Force
IP	Internet Protocol
ISO	International Organization for Standardization
LAN	Local Area Network
LAT	License administration tool
MIB	Management Information Base, used in SNMP to identify the data structure
MO	Managed Object
MS	Mobile station
MTBF	Mean Time Between Failures
NE	Network Elements, covering BSI, RRH, GES and NEMCOS Server
NEMCOS	Network Element Management, Control and Supervision System
NMS	Network Management System
NOC	Network Operation Center
NTP	Network Time Protocol



O&M	Operation and Maintenance
OAR	Off-air repeater
OID	Object Identifier
OSI	Open System Interconnection
PNG	Portable network graphics, originally designed to replace dated Gif file format.
POE	Power over Ethernet
POI	Point of Interface
PSE	Power Source Equipment
PSU	Power Supply Unit
QoS	Quality of Service
RF	Radio Frequency, is used as synonym for both real radio between RRH and Mobile and for Ethernet packets containing RF data between RRH and BSI
RFC	Request for Comments, used as recommendation and quasi standard in the ethernet world
RoHS	Restriction of Hazardous Substances
RRH	Remote Radio Head
RRH+	Summing RRH
Rx	Uplink (receiving path, forward path)
SMI	Structure of Management Information, the language that is used to define the MIB file
SMI	Structure of Management Information
SMIC	SNMP Management Information Compiler
SNMP	Simple Network Management Protocol
SNMP Communities	SNMPv1 / SNMPv2 use the notion of communities to establish trust between managers and agents
SNMPv2c	SNMPv2 technical name
SNR	Signal to noise ratio
STP	Spanning Tree Protocol
TBD	To be determined
TBSIL	Twin BSI left part
TBSIR	Twin BSI right part
TC	Textual convention
TCP	Transmission Control Protocol
TFTP	Tiny File Transfer Protocol, the little brother of the FTP protocol
Tx	Downlink (transmitting path, reverse path)
UC	Use Case
UDP	User Datagram Protocol
UL	Uplink (from mobile to BTS)
VLAN	Virtual Local Area Network. The CFS project will use the terms VLAN and Sector interchangeable.
WEEE	Waste of Electrical and Electronic Equipment

