In-building Coverage Solutions

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In-Building Solution

- What is an In-Building Solution & Why is it required ?
- It is a process, where in we radiate adequate Mobile signals of one particular Network operator in that entire building.

In places like basement floors, higher floors of some high rise Buildings, Airports, Corporate offices, Hotels & Shopping malls we tend to get signals from different cell sites around the building, so subscriber mobile ping-pong from one cell site to another resulting in high CALL-DROPS & High BER (Rx Quality)

In some case when the subscriber base increases, the Network operator has difficulty in planning new BTS. So instead of deploying a Macro Site the operator uses a Micro BTS where in the signal from Micro BTS will be distributed through out the building using Co-axial cables and distributed antenna system. By doing so, we will have uniform signal been radiated all through out the building providing an error free Network connection to all their valuable subscribers present in that building.

In the basement floors there will be absolutely no mobile signals present, so this problem also can be solved using a distributed antenna system in that floor.

Network Problems inside Buildings

- High Call Drops - Above 4th or 5th floors (Due to Multi cell Hand over)
- High Bit Error Rate - Due to Multipath propagation, Water refraction, Interference from other cell sites of same operator or other operators
- No network Coverage - Basements, Ground Floors etc. (Penetration loss)
- Subscriber base increases – If deployment of new BTS sites are not possible

Topics

1. In building Solution Proposals
2. Planning
3. Measurement
4. Implementation
5. In building acceptance testing

General RF Requirements of a customer

- **Quality of Service**
  - **Customer requirements > Rx level must be - 80dBm @ 95% Location Probability**
  - **Server from in building solution in dedicated mode > = 90%**
  - **Call Setup success rate = 98% in the entire building**
  - **Drop Call Rates < = 2%**
  - **DL Rx Quality (0 – 2) > = 90 % In the entire building**
  - **DL Rx Quality (0 – 4) > = 95 % In the entire building**
- **Spillage of signals must be < = -85dBm, on the street and the adjacent buildings**
- **Frequency planned for Indoor coverage must be carefully planned**
- **Parameter settings for IBS must be carefully planned (ex:- hopping frequency, MAIO, HCS etc.,**

Resources

Customers Radio Network Planner

NETWORK OPERATOR

RF Survey Engineer

Customer Site acquisition team

Can be the same person

Radio Network Planner (documentation)

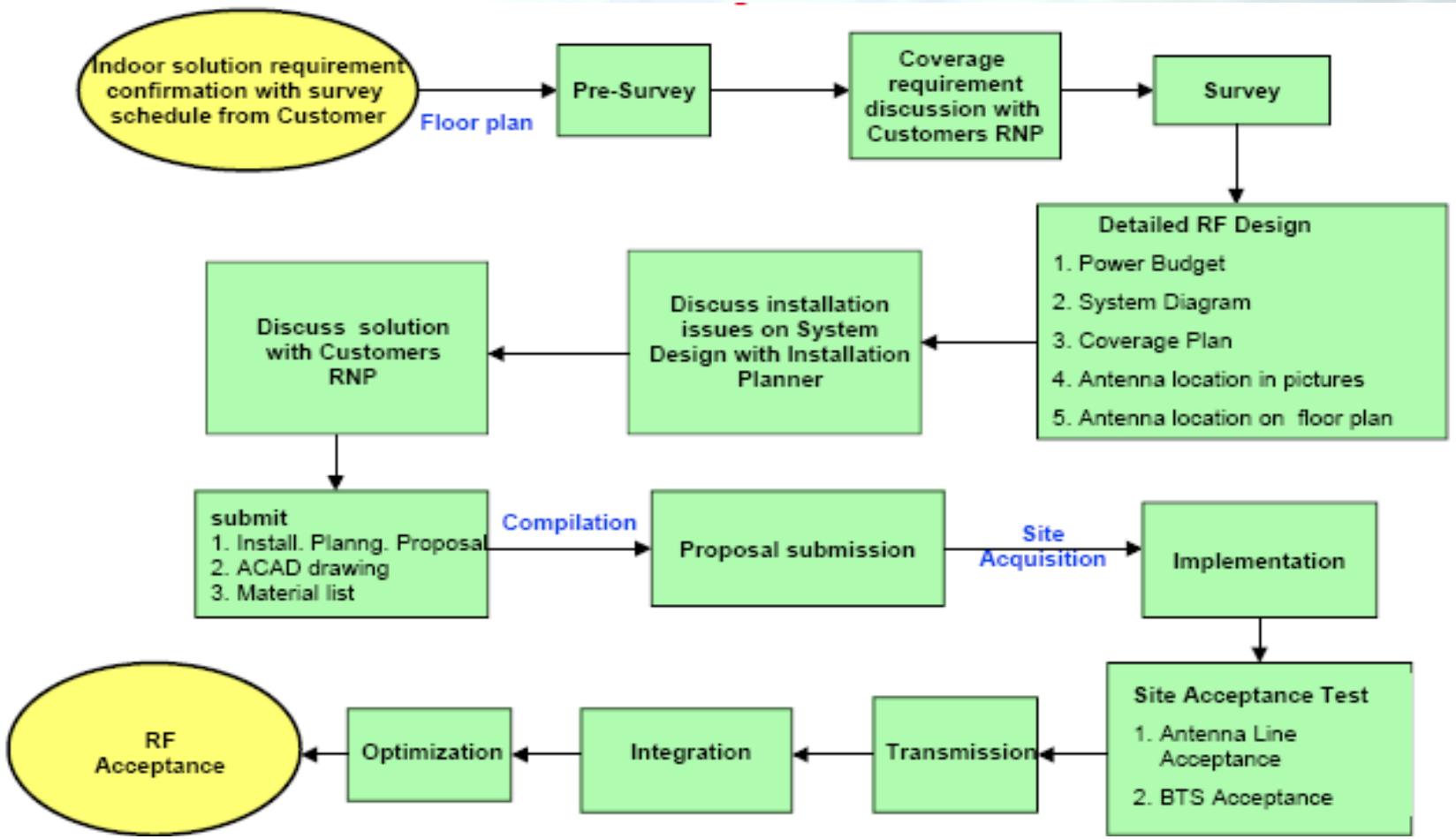
Installation Planner

Sub Contractor

Installation Supervisor

Process flow

In building survey & implementation roll - out



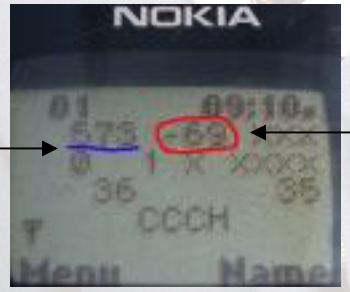
RF Survey with building floor plan

- Nokia phones with net monitor software loaded in it
- Readings need to be taken manually in different locations of the floor, the readings can be mapped on the floor plans for easy understanding
- TEMS LIGHT is an Ericsson Indoor walk test tool, connect the TEMS to the laptop, load the software and upload the floor plan of the building. Walk in the floors and record the signal levels, Final report will have signal details super imposed on the pre-loaded floor plans.

NOTE : For precise EIRP planning at each antenna, its advisable to use TEMS Transmitter for the survey, but a professional Radio planner is as good as a TEMS Transmitter.

RF Survey Tools

NOKIA NETMONITOR



TEMS LIGHT TOOL

TEMS TRANSMITTER TOOL

1. In building solution proposal

Radio Network Plan – RNP Report

- **Solution description**
  - Passive Distribution
  - CAT-5 Distribution
- **Coverage plan**
- **System diagram**
- **Power budget calculation**
- **Proposed antenna location photograph**
- **System layout on floor plan (ACAD)**
- **Measurement results**

RNP Report

Solution Description

Over view

Network Solution passive coaxial & Antenna distribution or LGC network

Coverage Plan (i.e.) Intended Coverage area

Based on the questionnaire or customers requirement, How many levels? Basement , Car park, Lift lobby, toilets, staff area etc., where all the coverage required

Bill of Materials

Details of How many antennas (Omni, Panel), Cable type (1/2" or 7/8"), Splitters, Couplers

Macro/ Micro BTS Accommodation

Type of BTS (Micro, Macro, flexi talk etc., based on output power)

BTS Location (to be placed in which floor ? Is there any other BTS installed by other network operators ?)

BTS configuration (1+1+1 or 2+2+2)

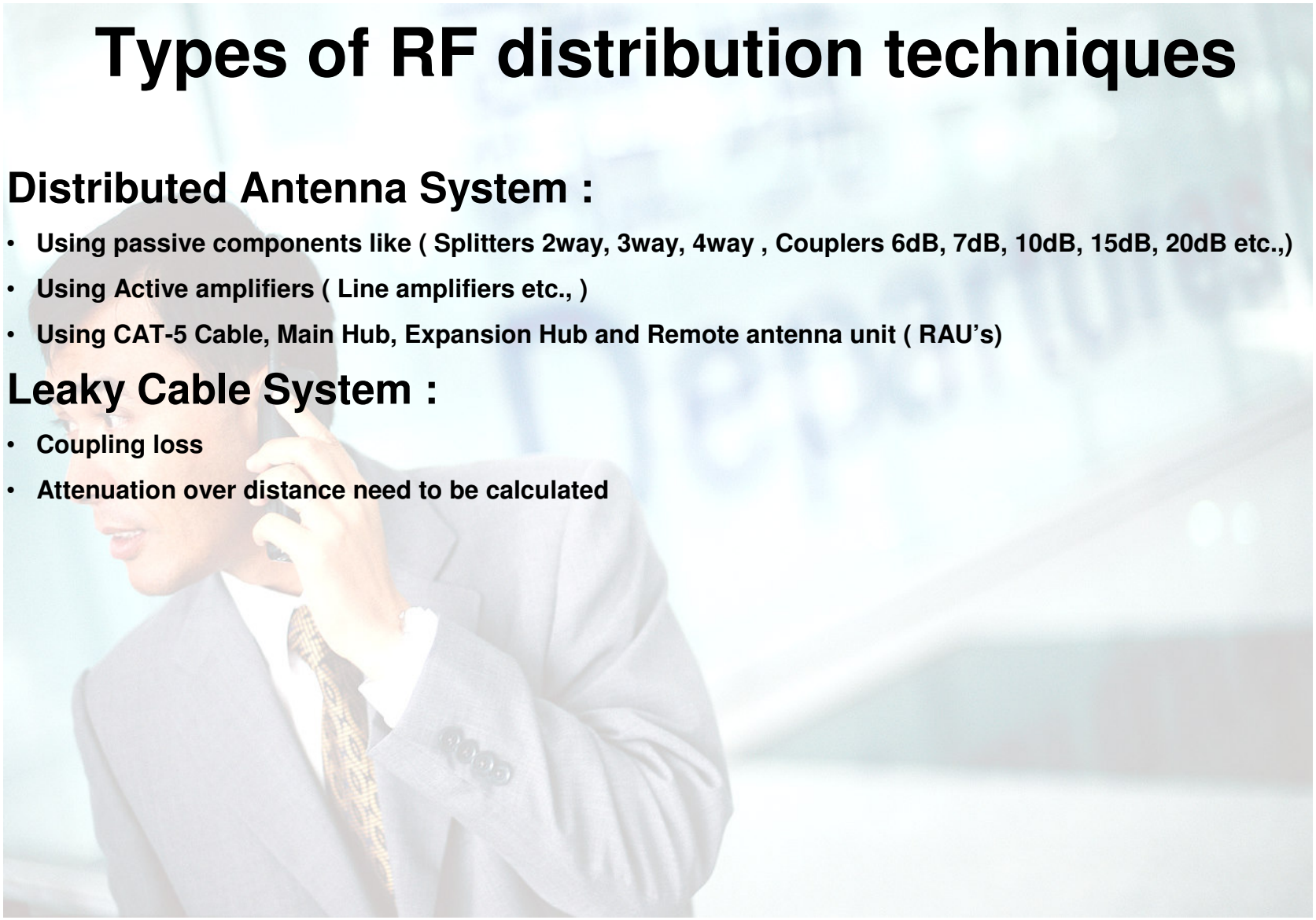
Electrical power supply for BTS

Power to be tapped from ?)

How to bring in E1 connection for the BTS

Should we put a separate electrical meter ? MCB required ? Etc.,

Types of RF distribution techniques



Distributed Antenna System :

- **Using passive components like (Splitters 2way, 3way, 4way , Couplers 6dB, 7dB, 10dB, 15dB, 20dB etc.,)**
- **Using Active amplifiers (Line amplifiers etc.,)**
- **Using CAT-5 Cable, Main Hub, Expansion Hub and Remote antenna unit (RAU's)**

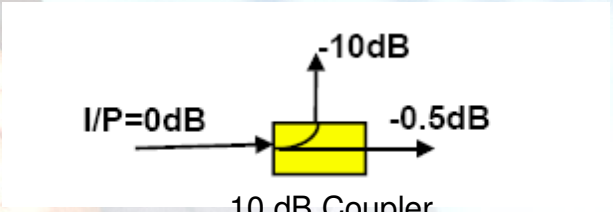
Leaky Cable System :

- **Coupling loss**
- **Attenuation over distance need to be calculated**

Passive Distribution Techniques

- Cable lengths more than 50mts has to be a 7/8" (Less loss)
- Use RF couplers for symmetrical power splits

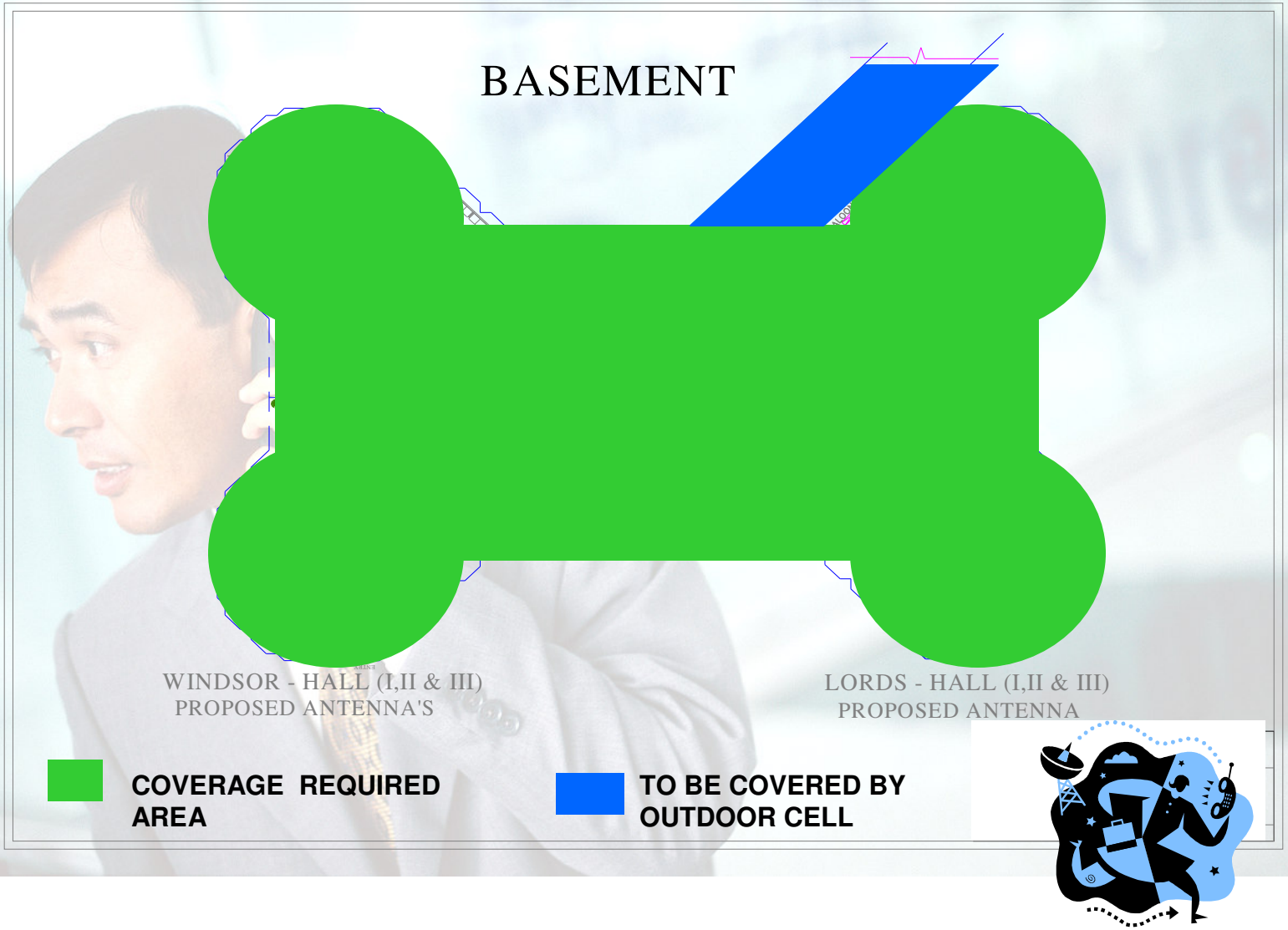
Coupler values are 3dB, 6dB, 7dB, 10dB, 15dB, 20dB & Variable couplers



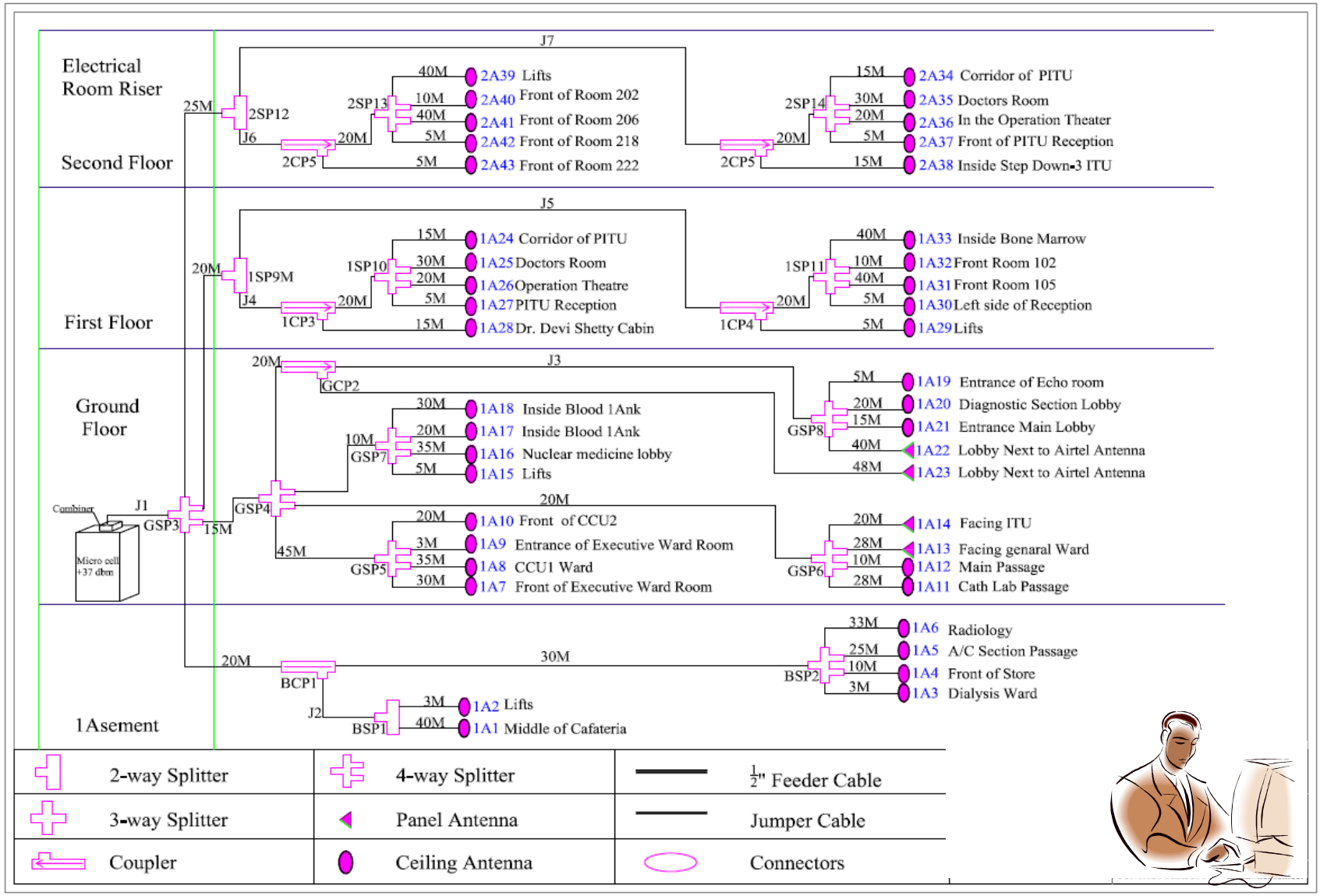
10 dB Coupler

- Design must have similar power distribution & coupling loss to each antenna
- Best design is to minimize the co-ax length as far as possible

2. Coverage plan



3. Trunking or System Diagram



Link Budget Calculation for each antenna

LINK BUDGET CALCULATION FOR UPLINK & DOWNLINK OF ALL ANTENNAS

Sl No	Antenna No	Length of cable			Splitter				Coupler					Connector Loss		Antenna Gain		Total losses (dB)	Antenna EIRP (dBm)	Link Budget Calculation	
									6 dB		10 dB									Up Link (RSSI at Micro BTS)	Down Link (RSSI at Mobile)
		1/2 inch	7/8 inch	Loss	2 way	3 way	4 way	Loss	Tap Loss	Through Loss	Tap Loss	Through Loss	Total Loss	Qty	Loss	Ceiling	Directional				
1	BA1	61	0	4.27	1	0	1	9	1	0	0	0	6	8	4	1	0	23.27	16.73	-49.48	-42.48
2	BA2	25	0	1.75	1	0	1	9	1	0	0	0	6	8	4	1	0	20.75	19.25	-46.96	-39.96
3	BA3	55	0	3.85	0	0	2	12	0	1	0	0	1.5	8	4	1	0	21.35	18.65	-47.56	-40.56
4	BA4	62	0	4.34	0	0	2	12	0	1	0	0	1.5	8	4	1	0	21.84	18.16	-48.05	-41.05
5	BA5	77	0	5.39	0	0	2	12	0	1	0	0	1.5	8	4	1	0	22.89	17.11	-49.1	-42.1
6	BA6	85	0	5.95	0	0	2	12	0	1	0	0	1.5	8	4	1	0	23.45	16.55	-49.66	-42.66
7	GA7	92	0	6.44	0	0	3	18	0	0	0	0	0	8	4	1	0	28.44	11.56	-54.65	-47.65
8	GA8	97	0	6.79	0	0	3	18	0	0	0	0	0	8	4	1	0	28.79	11.21	-55	-48
9	GA9	65	0	4.55	0	0	3	18	0	0	0	0	0	8	4	1	0	26.55	13.45	-52.76	-45.76
10	GA10	77	0	5.39	0	0	3	18	0	0	0	0	0	8	4	1	0	27.39	12.61	-53.6	-46.6
11	GA11	65	0	4.55	0	0	3	18	0	0	0	0	0	8	4	1	0	26.55	13.45	-52.76	-45.76
12	GA12	47	0	3.29	0	0	3	18	0	0	0	0	0	8	4	1	0	25.29	14.71	-51.5	-44.5
13	GA13	65	0	4.55	0	0	3	18	0	0	0	0	0	8	4	0	1	26.55	17.45	-52.76	-41.76
14	GA14	57	0	3.99	0	0	3	18	0	0	0	0	0	8	4	0	1	25.99	18.01	-52.2	-41.2
15	GA15	32	0	2.24	0	0	3	18	0	0	0	0	0	8	4	1	0	24.24	15.76	-50.45	-43.45
16	GA16	62	0	4.34	0	0	3	18	0	0	0	0	0	8	4	1	0	26.34	13.66	-52.55	-45.55
17	GA17	47	0	3.29	0	0	3	18	0	0	0	0	0	8	4	1	0	25.29	14.71	-51.5	-44.5
18	GA18	57	0	3.99	0	0	3	18	0	0	0	0	0	8	4	1	0	25.99	14.01	-52.2	-45.2
19	GA19	44	0	3.08	0	0	2	12	1	0	0	0	6	8	4	1	0	25.08	14.92	-51.29	-44.29
20	GA20	59	0	4.13	0	0	3	18	0	1	0	0	1.5	10	5	1	0	28.63	11.37	-54.84	-47.84
21	GA21	54	0	3.78	0	0	3	18	0	1	0	0	1.5	10	5	1	0	28.28	11.72	-54.49	-47.49

NOTE:

UPLINK & DOWNLINK Budget are calculated at a distance of 25meters from the Antennas

Body loss = 3 dB

Indoor Multipath faded margin loss (incase of more partitions) = 6 dB

Total loss = 9 dB

An additional loss of 9 dB has to be taken into account in both uplink and downlink RSSI

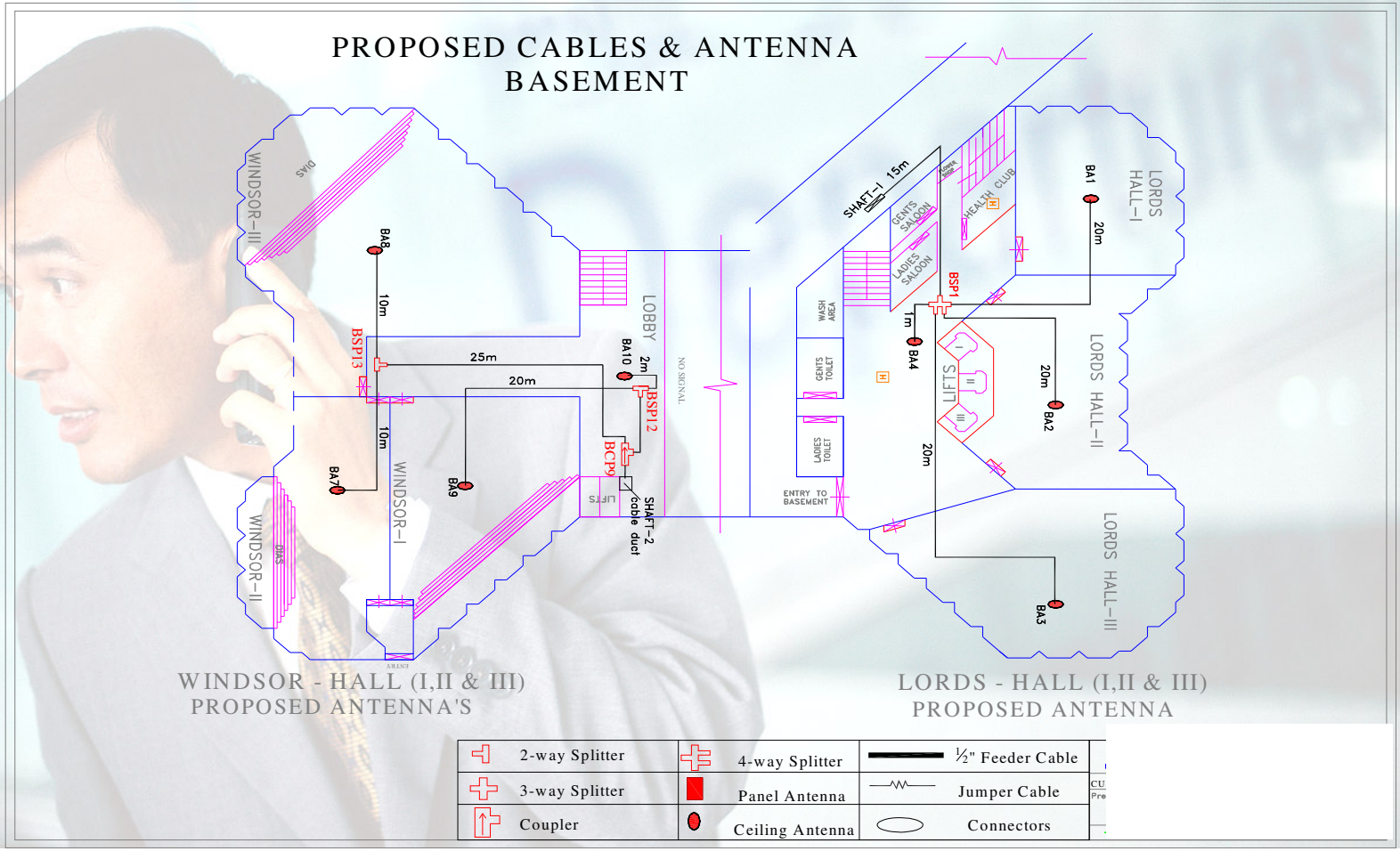
Antenna Location with Photograph

A-L1-3 (Above the information counter)

A-L3-1 (On the side wall of shop no. 03-36)

RNP Report

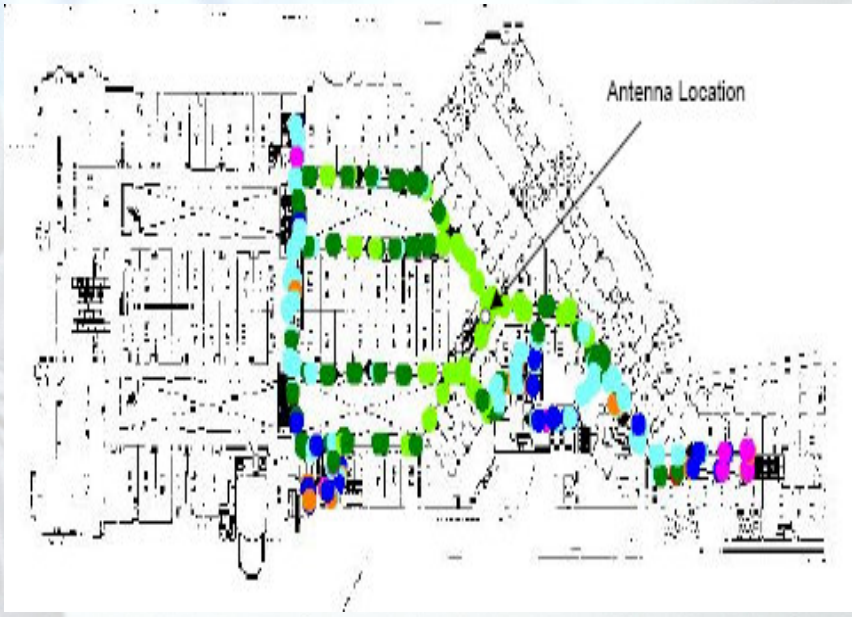
Floor plan with Antenna Location marking



Existing Signal level measurements

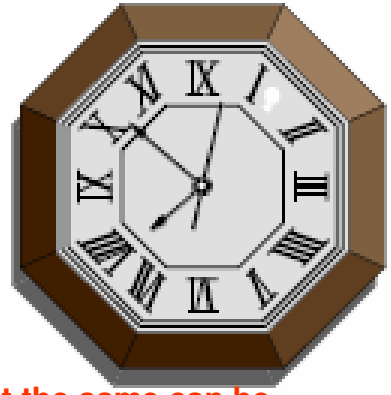
NOKIA NET MONITOR DESIGN

TEMS TOOL DESIGN



Planning (duration)

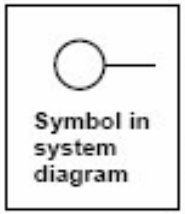
- **Pre survey (discussion with Network operator & coordinator) 0.5 day**
- **Survey + Measurement (1 day for a moderately big building) 1 person from Operator side also required**
- **System diagram, Antenna location, Power budget calculation etc., (1 day Max)**
- **Report preparation in ACAD (1 day)**
- **Compilation of the proposal and preparing a final plan (1 day)**



NOTE : Total about 4.5 days are required for planning and report preparation, but the same can be squeezed in 3 to 4 days Max, Quicker than this, will be a compromise on quality

Planning of Accessories

Omni antennas



Antel Omnidirectional antenna

- Gain 2.1dBi
- 360 deg.
- Dimensions 205*67mm
- N-female connector

Kathrein 737602 omnidirectional antenna

- Gain 2 dBi
- 360 deg.
- Dimensions 200*70*110mm
- N-female connector

Note: Size & shape of the antenna (round, flat) can vary depending upon customer's request

Planning of Accessories

Directional or Panel antennas

Symbol in system diagram

Kathrein 736395 directional antenna

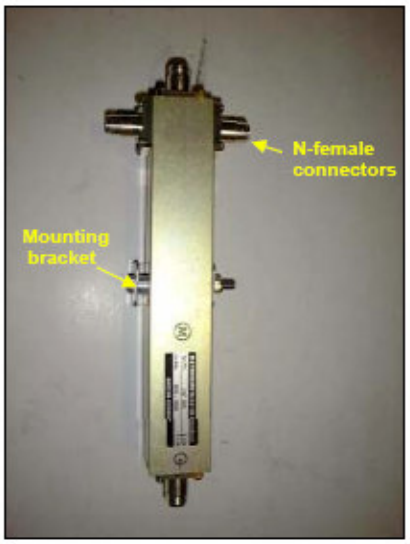
- Gain 8 dBi
- 90 deg.
- Dimensions 290*105*30mm
- N-female connector with 1m RG58/CU tail cable

Note: Size & shape of the antenna (small, big) can vary depending upon customer's request

Planning of Accessories

Splitters & Couplers

2 way



3 way

4 way

Note: Couplers will be same like 2 Way splitters but the output port in the sides are little long from the other port.

Planning of Accessories

Feeders or Cables

Note: ½" Cable comes without super flex also and that is what is used in most of the IBS, similar to RFX ½" Leaky cable, but no holes on the corrugation

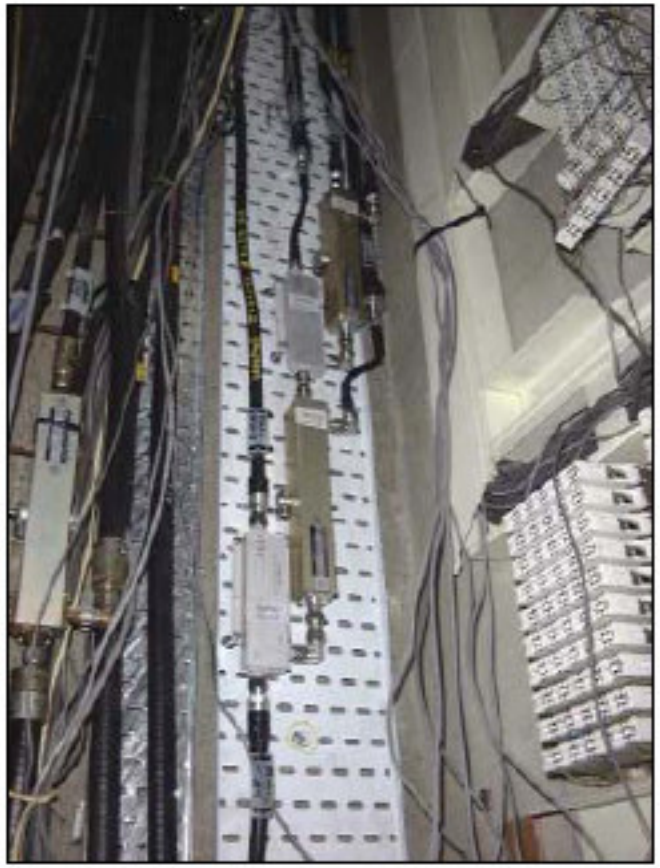
Implementation

- Site in-charge or a Project engineer (1 person)
- Skilled technician to make connectors (1 person)
- Sub contractors well versed of cable laying
- For an average size building with 30 antennas and 1000 meters of cable can be completed in 7 days time, provided there is no hindrance from the building owners
- Cables, Splitters, Couplers & Antennas (If possible) must be named during installation
- Cable lengths to be marked along with the cable names during implementation
- Cables to be neatly cable tied at every 2 mts of length
- VSWR measurements of all cables(along with antenna connected) must be noted down during installation
- Clamps are to be provided for ceiling and panel antennas, incase if there is no wall support
- appropriate tools to be used for making connectorisation

Implementation

Example of Coupler & Splitter installation in a cable tray

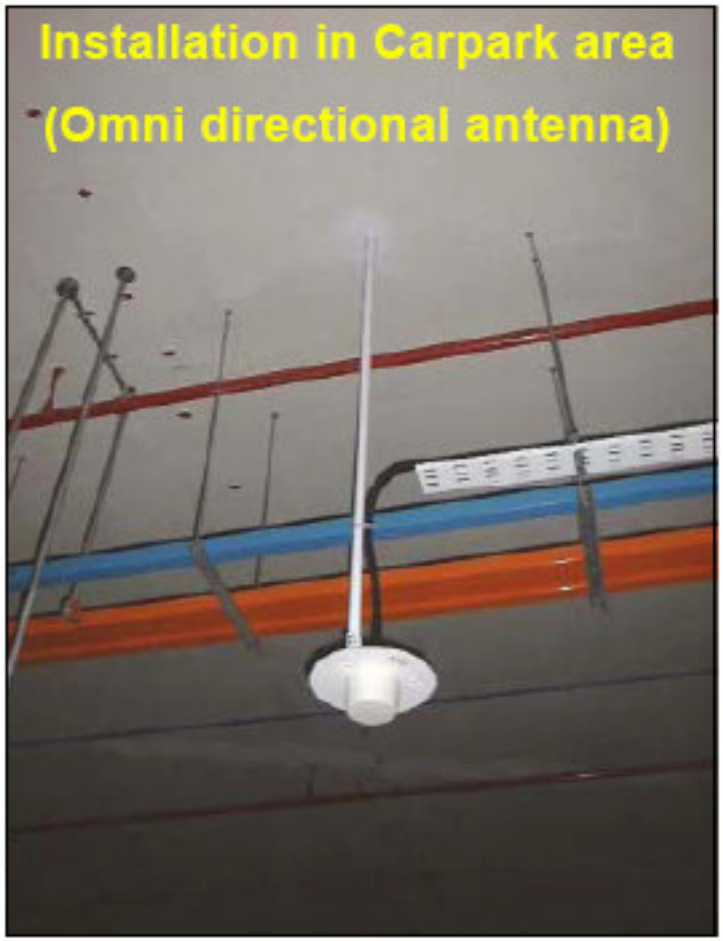
Coupler to Coupler



2 Couplers and 2 Splitters together

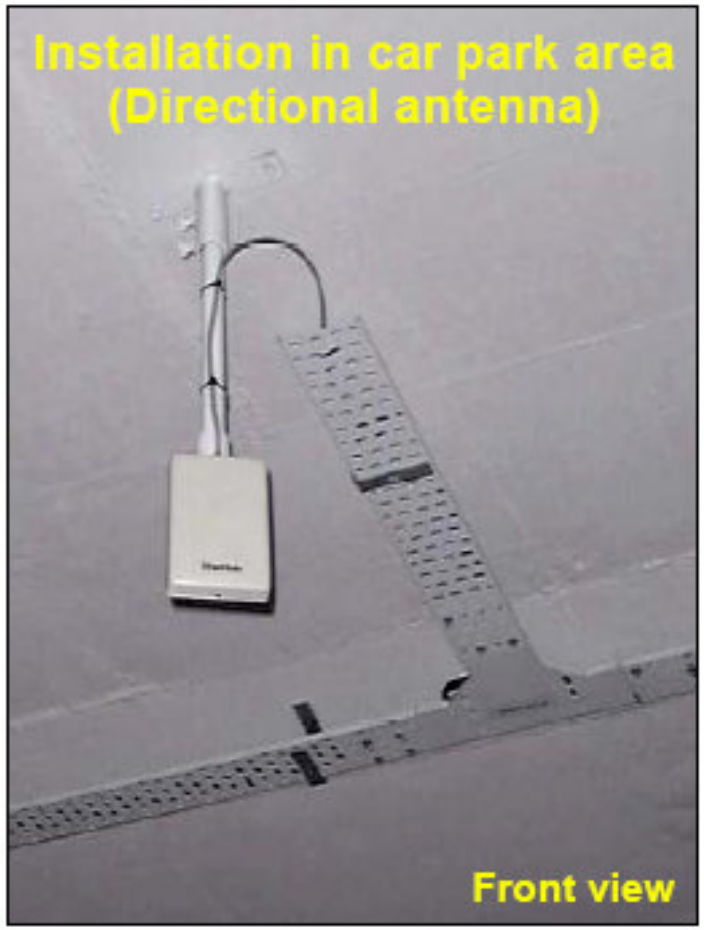
Implementation

Example of Ceiling antenna installation



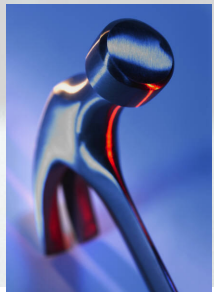
Implementation

Example of Panel antenna installation



Tools required for implementation

- Prep tool
- Chamfer tool
- Crimping tool
- Quality Knife
- Hack saw Frame & Blade
- Shaping tool
- Cutter
- Spanner set
- Screw driver set
- Soft Hammer



Measurement Equipments required for Implementation

BIRD SA 2500 EX Site Analyzer

ANRITSU S 331A Site Analyzer

Both are used to measure

- **VSWR**
- **Return Loss**
- **Distance to Fault finding**
- **Measure RF power to certain level**
- **Can be interfaced with PC or Laptop to get Graph of VSWR**

Acceptance Testing

Materials or Accessories Check

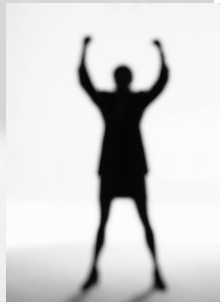
- Physically check the implementation (any loose cabling, physical damage on feeders, antennas clamped properly etc.,)
- VSWR check for sample cables (it is highly impossible to check VSWR for each cable in inbuilding solution, the reason is we have more than 100 pieces of cable in an average building, testing all the 100 will fetch entire 2 days & more over some cables will be inside the false ceiling)
- Check the list of inventory's used in that particular site
- Sample check the implemented cable lengths (Checking all the feeder physically might not be possible)

Electrical & Ground Check

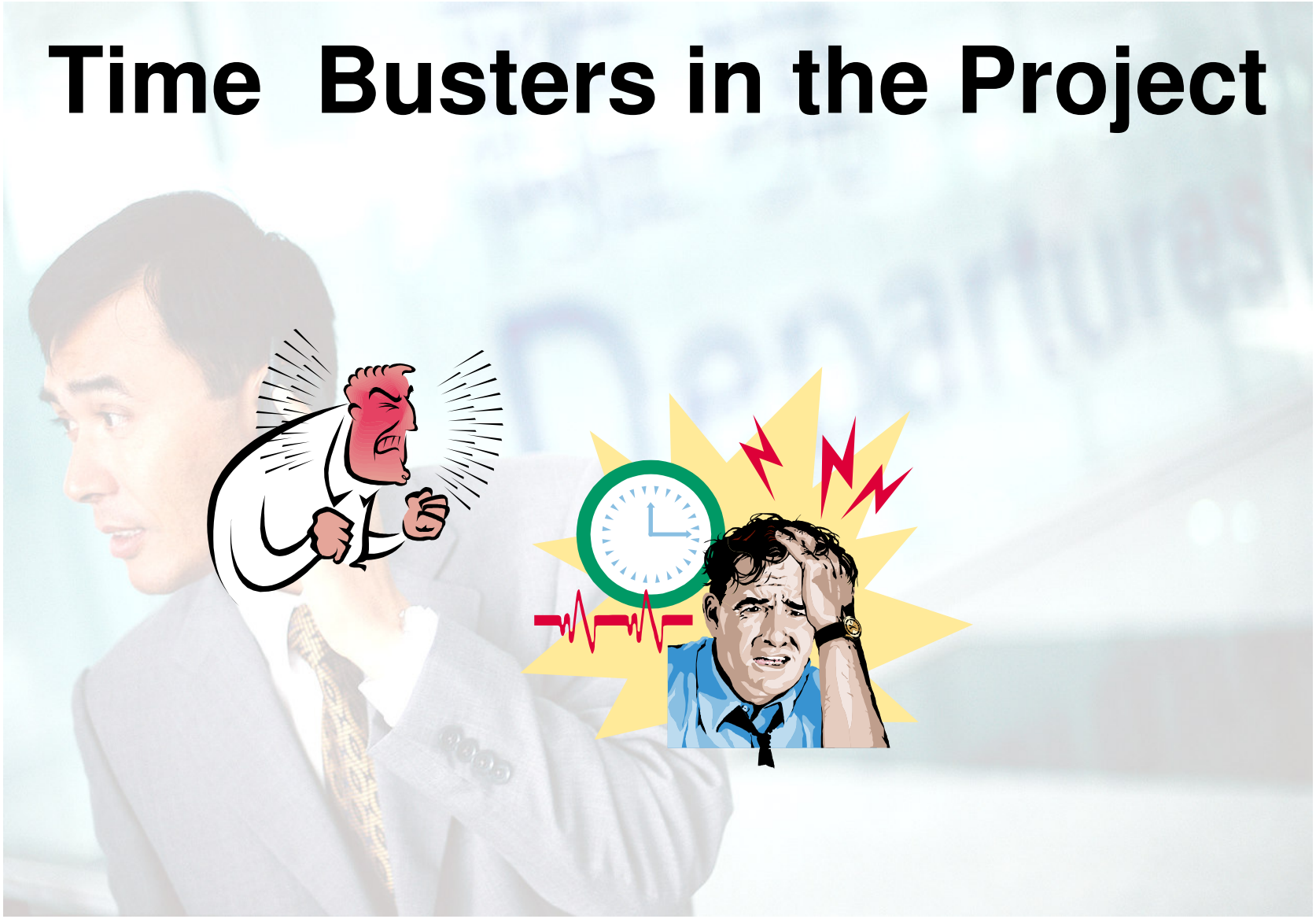
- Check the power connections of Micro BTS (Voltage check, Grounding, Fixing etc.,)
- Feeder cable connected to the output of micro cell has to be grounded properly using grounding kit
- Ventilation in the room to be checked

RF Signal Check

- Check the signal levels (Idle mode) at places mentioned in the RNP report
- Check Call Setup, Call quality, Call sustain and Call hand over to Outdoor cells
- Check for the in building cell Signal spill over



Time Busters in the Project



What might go wrong – Time Busters

- **MICRO BTS LOCATION CHANGE**

  > Due to building owner's decision
  > New plan needs to be done, Re-design
  > Unforeseen, sometimes dependent upon site acquisition team relationship with the building owner

CABLE ROUTING CHANGES

> Due to inaccessibility of some riser, certain parts of ceiling, renovations etc.,
> again redesign the plan
> Incase of hotels, we will not get permission if guests are more or meetings going on in the Ball rooms
> Incase of any accidents during implementation
> If coverage area not defined properly by the network operator during initial RF survey
> Shortage of cables or any other accessories during implementation process

Note: Project planning, implementation issues not handled properly leads to extra unforeseen amount of time & money spending during optimization