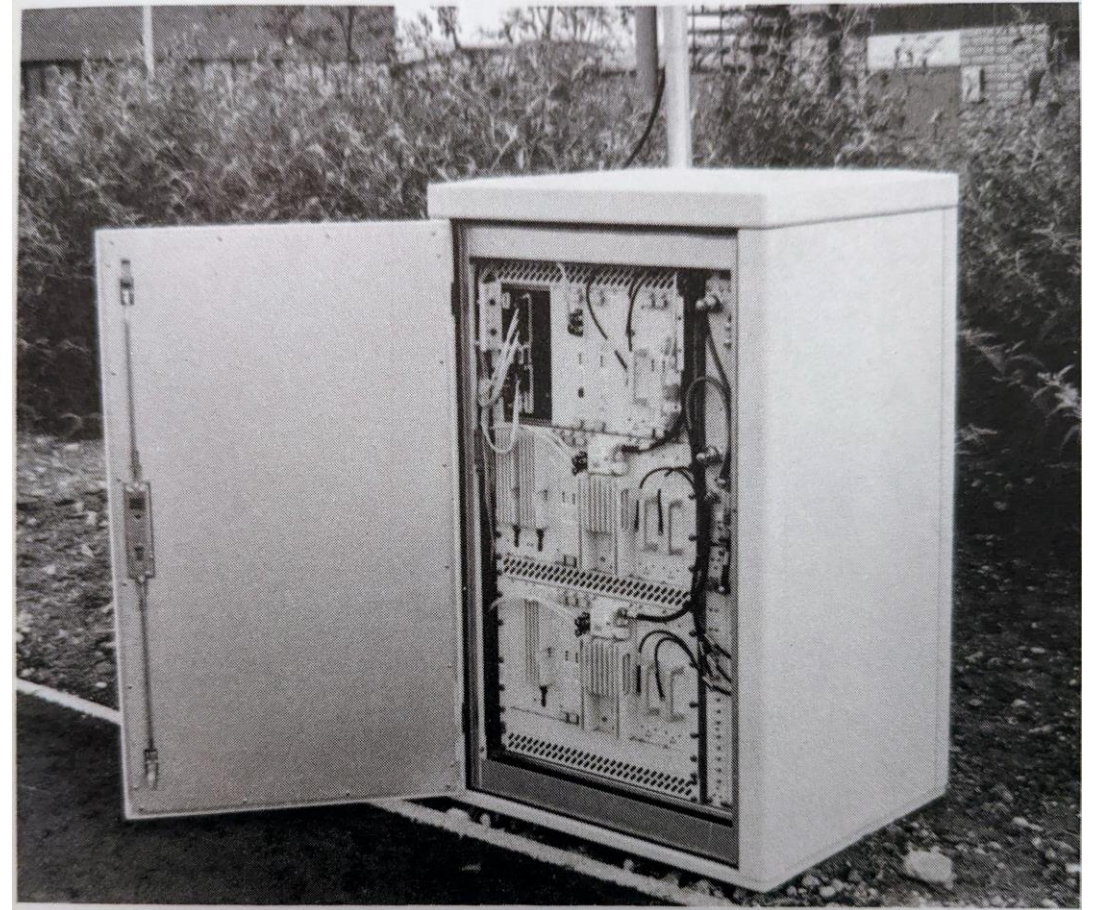


Orange Class 3.x BTS

GSM 1800 BTS and its evolution from
Nokia DF-12 to DF-34

Introduction

- The Class 3.0 BTS was one of two original BTS site designs implemented by Orange, the other being the Class 2.0 (see: <https://2g-gsm.co.uk/orange-class-2-0-bts>)
- The Class 3.0 BTS was an integrated outdoor cabinet which supported 2 x GSM 1800 TRXs in a single cabinet and 4 x GSM 1800 TRXs in a two-cabinet configuration
- The two-cabinet configuration was the most common deployment scenario for Orange as the site was used in the main, for a 3-cell sector configuration, 1+1+1
- The two-cabinet configuration supported a fourth TRX which could be added to any of the three cell sectors by configuring the physical RF combiner output to coaxial feeder connectivity within the roof space of the cabinet
- In rare scenarios where a single cabinet was deployed, this would be configured as a 1 or 2 x TRX omnidirectional site



Source: The GSM System for Mobile Communications by Michel Mouly & Marie-Bernadette Pautet

Orange BTS designations

- Orange allocated a specific 'BTS Class' designation to each BTS variant, the full list is shown here...
- This document relates to those BTS types identified as Class 3.x and highlighted within the red box
- While listed as 33, these BTS were refereed to as 3.3 (three dot three), this format was used throughout the Orange era
- This number scheme was used in the Infrastructure Management System (IMS) database which was the central repository for network information
- This scheme continued to be used by Orange until the company merged with T-Mobile in 2010 to form Everything Everywhere, later known as EE

2 BTS

The table below shows the different class of BTS that are in use in the network along with the Trx capacity, number of cabinets, location and common name.

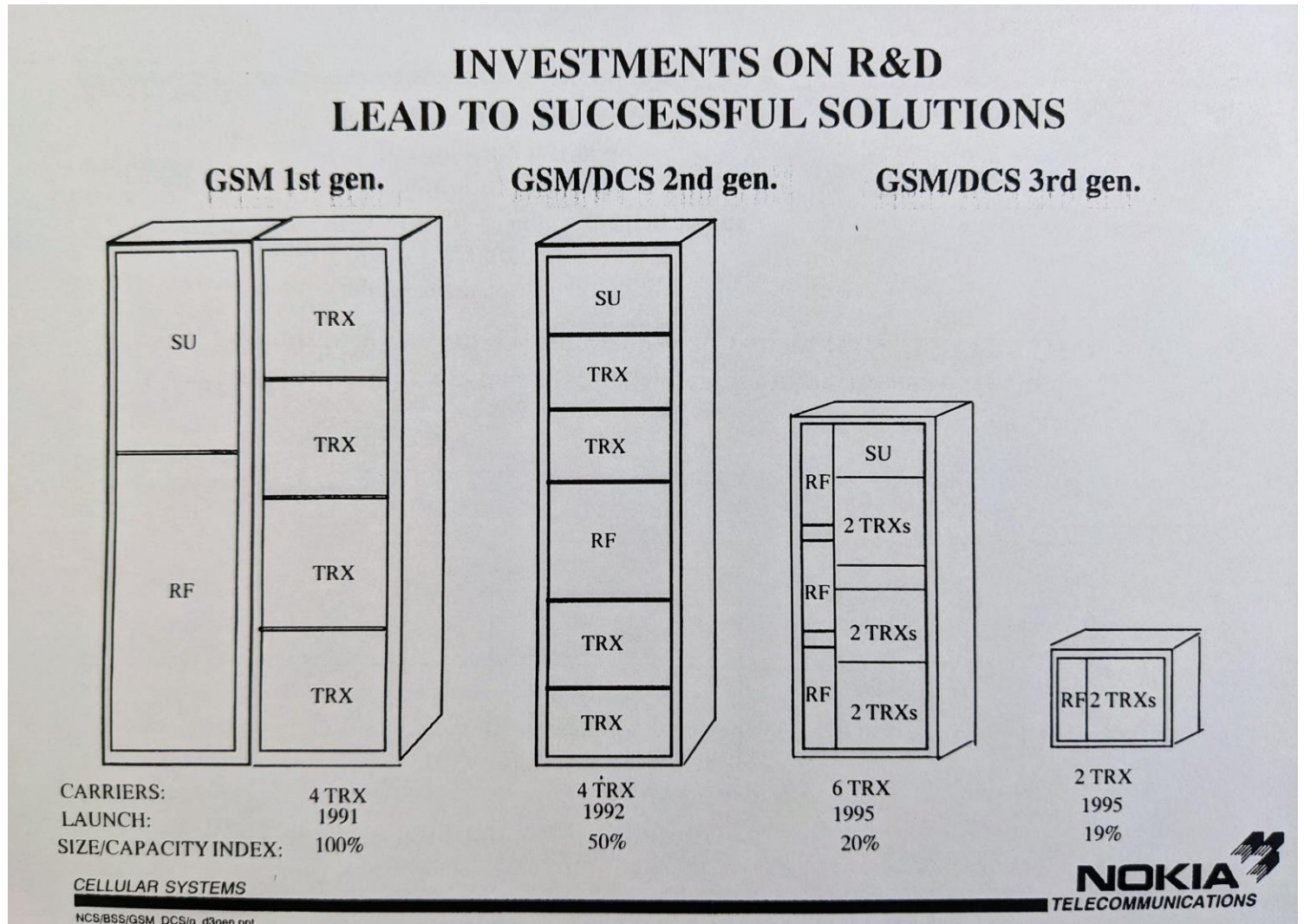
BTS Class	Internal / External	Cabs	Trx Capacity	GSM / UMTS	Common Name	Notes
2	Both	1	4	GSM	Class 2	
3	External	1	2	GSM	A rack	
3	External	2	4	GSM	A + B rack	
3.1	External	1	2	GSM	G rack	
3.1	External	2	6	GSM	G + H rack	
3.2	External	3	10	GSM	G + H + M rack	
33	Both	1	6	GSM	P rack (external) S rack (internal)	
33	Both	2	12	GSM	P + R rack (external) S + T rack (internal)	
34	Internal	1	6	GSM	S rack	AC variant
40	Both	1	12	GSM	Ultrasite	
41	Both	1	12	GSM	Ultrasite	AC variant
42	External	1	6	GSM	Midi	
50	Both	1	6	UMTS	Supreme	
51	External	1	6	UMTS	Compact	
52	Internal	1	6	UMTS	Supreme	AC variant
60	Both	1	1	GSM	PrimeSite	
61	Both	1	2	GSM	Mini BTS	Wall Mounted
62	Both	1	2	GSM	Mini BTS	Plinth Mounted
63	External	1	4	GSM	1W Metrosite	Not used
64	External	1	4	GSM	5W Metrosite	
80	External	1	1	UMTS	UMTS Metrosite	

Table 1 *BTS Class*

Note, the terms cab, cabinet and rack are used interchangeably...

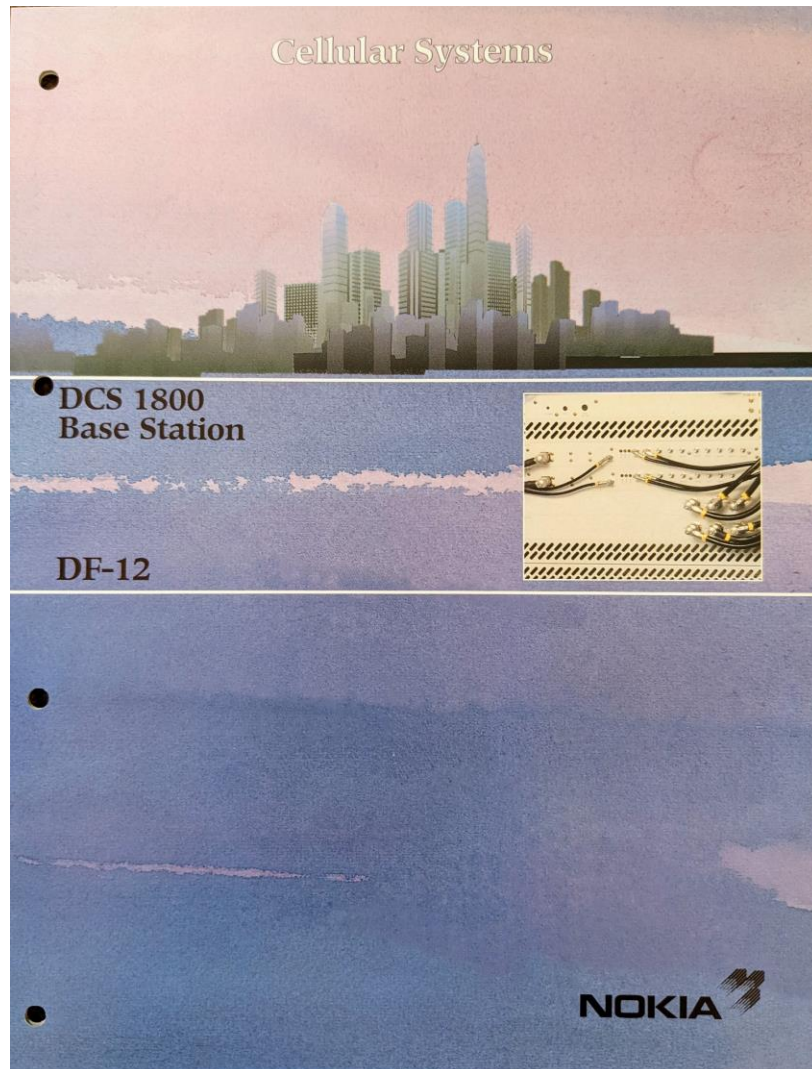
Nokia GSM BTS developments during the 1990s

- This image highlights the evolution of Nokia's GSM 900/1800 BTS products
- At this stage GSM 1800 is still represented as DCS...
- Orange 3.0 BTS was a Nokia 2nd gen BTS split to fit in two short outdoor racks, with support for 4 x TRX
- Orange 3.1 BTS was a modified DF-12 base station which supported 6 x TRX in the same form factor as the 3.0, this was achieved by changing the layout of plug in units and developing modified RF components for the second cabinet
- Orange 3.2 BTS was a 3.1 with an additional (third) cabinet which increased the overall site capacity to 10 x TRX, therefore 3+3+4 was possible...



Source: Orange Nokia DF-34 BTS training course notes - 1997

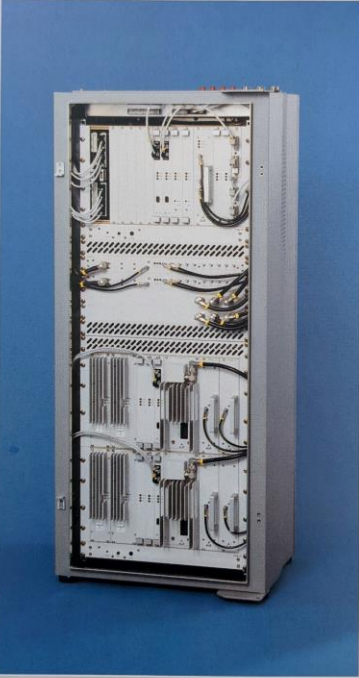
Nokia DF-12 BTS - used in Orange 3.0, 3.1 & 3.2 BTS



DCS 1800 Base Station, DF-12

Main Features

- Capacity up to 4 TRXs, 32 channels in one cabinet
- Maximum configuration two cabinets, 10 TRXs, 80 channels
- Two cabinet types available: 130 cm or 210 cm high
- Access to the cabinet is front only
- All external connections on the top of the cabinet
- Both DC and AC power supplies are available
- Integrated battery backup with AC power supplies is optionally available
- Transmitting output power 20 W
- Wideband TX antenna combining system
- Receiver diversity optionally available
- Frequency hopping included as a standard feature
- Local MMI for monitoring and controlling the BTS equipment
- Integrated Abis submultiplexing equipment for point to point and multidrop connections
- Optionally redundant common units



The image shows a tall, silver-colored metal cabinet of the Nokia DCS 1800 Base Station DF-12. The front panel is open, revealing the internal components, including multiple circuit boards, cables, and connectors. The cabinet is set against a blue background.

Indoor mini BTS

- Two TRXs, 16 channels, in the first cabinet
- Maximum configuration two cabinets, 4 TRXs
- Dimensions (h x w x d) 1.3 x 0.6 x 0.45 m

Nokia DF-12 BTS - used in Orange 3.0, 3.1 & 3.2 BTS

Base Station for PCN applications

The option to deploy cellular services also in the 1.8 GHz band is in accordance with the desire to fully exploit the European investment in the ETSI GSM specification and equipment design. Based on its experience with 900MHz GSM base stations, it is only logical, that Nokia is in the forefront of suppliers offering DCS 1800 Base Transceiver Stations (BTS).

Nokia was one of the first suppliers to be awarded a complete PCN system contract. It was chosen because of its commitment to quality, its reputation to deliver on time, and its capability to deliver a full set of services and features.

The air interface and network termination is a Nokia designed and constructed Base Transceiver Station (BTS) developed to comply with the ETSI DCS 1800 specifications.

Recognizing the significance of cell site costs in the total cost of network operation, Nokia is continuously seeking solutions to reduce the size of equipment as well as providing more flexibility for the network operator in actual site arrangement. This aspect is growing in importance in the high volume DCS 1800 market.



Indoor mini BTS

Technical data

DCS

Base Station

Electrical data

TX frequency:	1805 - 1880 MHz
RX frequency:	1710 - 1785 MHz
Channel spacing:	200 kHz
Available radio channels:	374
TX output power at combiner input:	20 W dynamic power control range 30 dB in 2 dB steps
RX sensitivity:	better than -104 dBm

Power feeding

- 27 VDC (24 - 30 VDC)
- 48 VDC (41 - 72 VDC)
- 230 VAC (200 - 270 VAC)

- total power consumption:

common units of the BTS:	500 W
transceiver, at full output power:	300 W/TRX

example: total power consumption of a BTS/2 TRX: 1100 W

Mechanical dimensions (height x width x depth mm)

Standard omni BTS:

- up to 4 TRXs, one cabinet: 2100 x 600 x 450
- up to 10 TRXs, two cabinets: 2100 x 1200 x 450

Mini BTS:

- up to 2 TRXs, one cabinet: 1300 x 600 x 450
- up to 4 TRXs, two cabinets: 1300 x 1200 x 450

Environment

Temperature range:	-10 ... +50 °C
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For more details, please consult Nokia Telecommunications, Cellular Systems.

All Nokia products are subject to continuous research and development; we therefore reserve the right to alter technical specifications without prior notice.

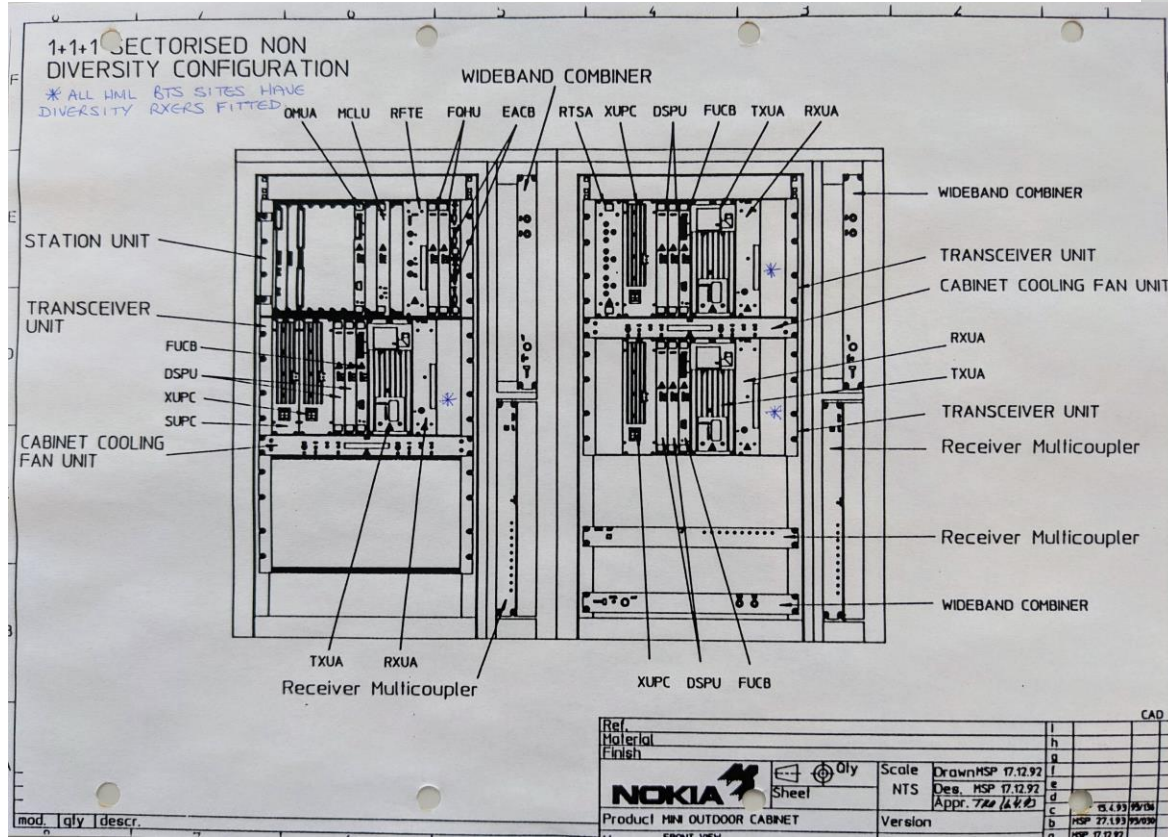
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Nokia DF-12 BTS as Orange 3.0 BTS

Known as A and B cabs/racks, Orange configuration used two receivers for diversity reception, this is common with all Orange BTS types, receive diversity enhances the cellular uplink.



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CONTENTS - MOCA UNIT DESCRIPTIONS

MOCA BTS UNIT DESCRIPTIONS - CONTENTS

Abbreviations

1	BASE TRANSCIVER UNIT	TRXU
2	FRAME UNIT CONTROLLER BOARD	FUCB
3	DIGITAL SIGNAL PROCESSING UNIT	DSPU
4	TRANSMITTER	TXUA
5	RECEIVER	RXUA
6	STATION UNIT	SU
7	OPERATION AND MAINTENANCE UNIT	OMUA,OMUB
8	MASTER CLOCK UNIT	MCLU,MCLP
9	FREQUENCY HOPPING UNIT	FQHU
10	RF TEST EQUIPMENT	RFTE
11	EXTERNAL ALARM & CONTROL BOARD	EACB
12	BASE STATION INTERFACE EQUIPMENT	BIE
13	RECEIVER MULTICOUPLER	RXMC
14	TRX POWER SUPPLY UNIT	XUPD,XUPE, XUPF
15	SU POWER SUPPLY UNIT	SUPA,SUPB,SUPC
16	WIDEBAND COMBINER	WBCO
17	TRANSMITTER DUPLEX FILTER	TXDF
18	CABINET COOLING FAN UNIT	CCFU

NCS/BS/UK 1.0.0

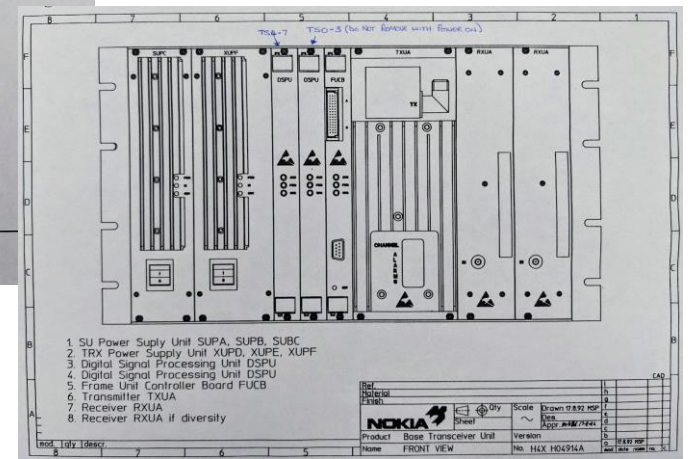
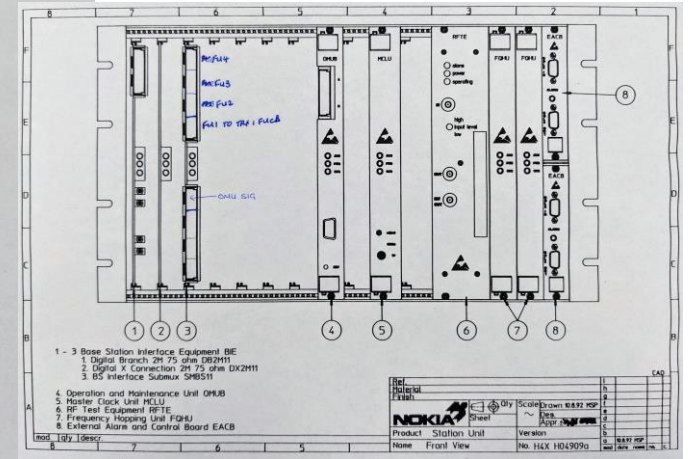


Diagram shows 1+1+1 configuration, the 4th TRX would be added to the bottom TRX shelf of the first cabinet and then these 2 TRXs would be connected to the sector which required the additional capacity by connecting to the appropriate set of RF coaxial feeders in the roof-space of the BTS. Cell site could be configured as 1+1+2 or 1+2+1 or 2+1+1.

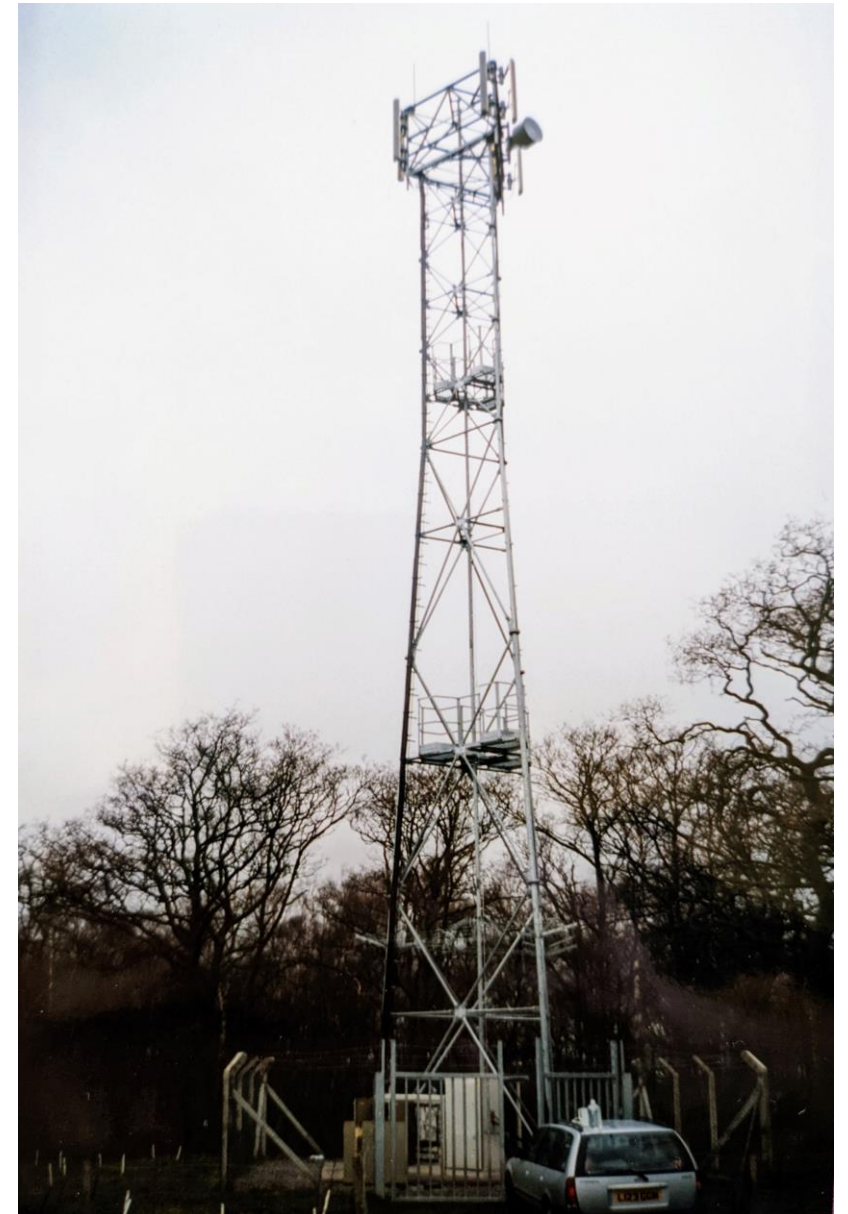
Orange cell sites

Below - Orange class 3.x BTS site, likely a 3.1 - photo from 1998

Andrew Antennas (now Commscope) LDF-550 coaxial cable used as RF feeder/transmission line from BTS to what looks like LDF-650 coaxial feeder run to the antennas; the thicker cable has lower attenuation so is used on longer cable runs to keep within the target maximum 2dB cable loss, to maximise the RF coverage of the site

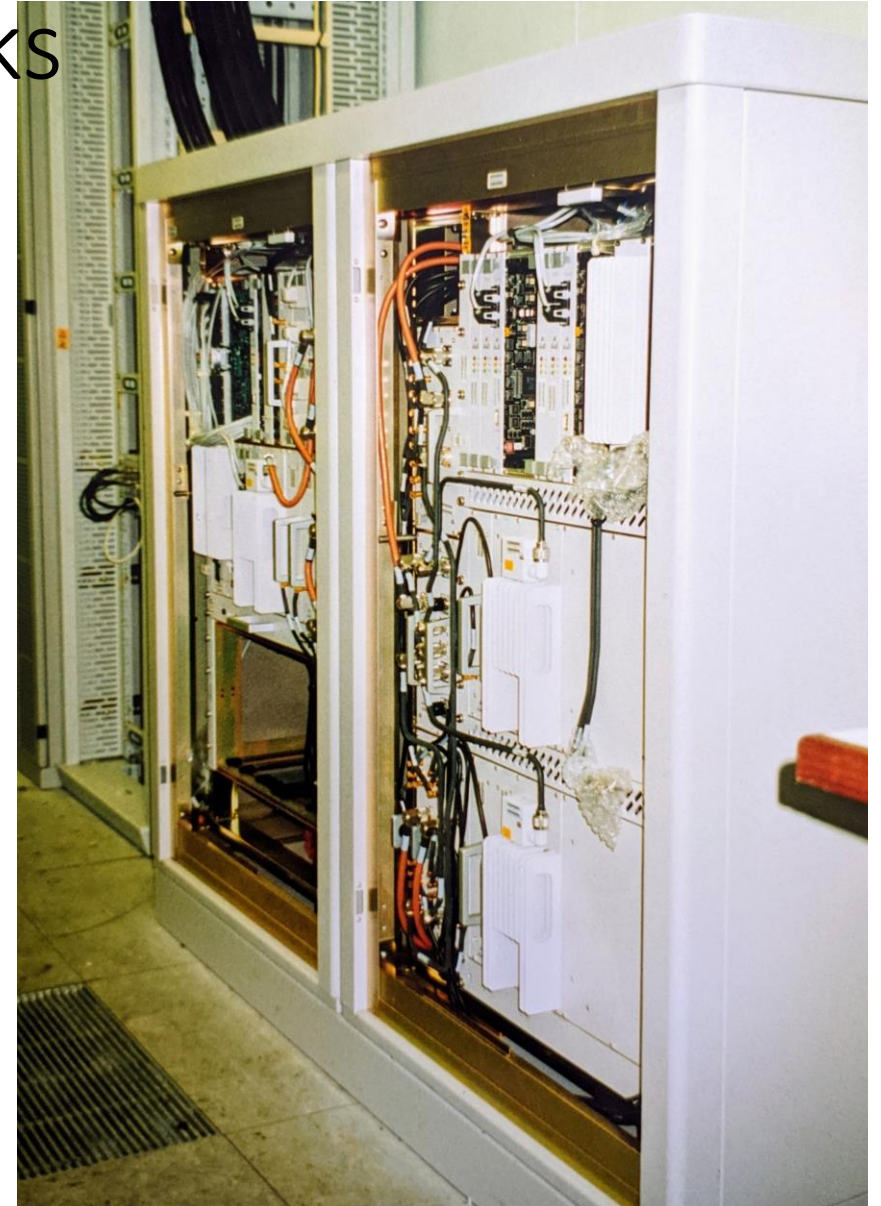


- Right - Swann B2-3 lattice tower configured as 3 cell sectored site with 1+1+1 BTS
- BTS is Orange Class 3.0
- Nokia DF-12 equipment
- Taller cabinet is TXC, this was a joint power and transmission cabinet
- Site has a microwave link for backhaul



Orange 3.1 BTS - G & H cabs/racks

- Class 3.1 BTS supports 6 x GSM 1800 TRX and therefore enables a maximum configuration of 2+2+2
- The photo illustrates a 3.1 with 1+1+1 configuration
- The left cabinet, known as G cab, is effectively the same as the A cab of the 3.0 BTS, the right cabinet is a completely new layout, this is known as a H cab
- The H cab used the same plug-in units as any other DF-12 BTS however to make 4 x TRX fit in this form factor, the RF components were redesigned and optimised for the number of RF ports required
- The G cab has a wideband combiner, transit duplex filter and 2 x receive multi-couplers, as per the A cab (& Class 2.0 BTS)
- The new RF components in the H cab were; antenna combiner (AFAX), antenna duplex filter (AFDA) and antenna filter low noise amplifier (AFLA)
- The layout of the H cab introduced two new shelf types, a Frame Unit (FU) shelf which is located at the top of the cab and supports four sets of frame unit control board and digital signal processing cards plus power supply
- The middle and lower shelves are Carrier Unit (CU) shelves, these contain 2 x TRX each, each TRX consists of two receivers and 1 transmitter, along with power supplies



Orange 3.2 BTS - G, H & M cabs/racks

- As traffic volumes started to grow due to the significant adoption of mobile-phones, and growth in usage, it was necessary to increase the capacity available on a cell site
- To manage this in the mid 1990s Orange worked with Nokia to develop the Orange 3.2 BTS
- 3.2 added another 4 x TRX to the existing 6 x TRX 3.1 BTS through the use of an extension cabinet
- This third cabinet was known as an M rack (or M cab) and was connected back to the original two cabinets by an umbilical cable
- The M rack was the same configuration as the H cab (rack)
- To enable more than 2 x TRX per cell sector the solution implemented dual-duplexing as the maximum number of TRX per antenna was two (based on the RF combiners), therefore 1 or 2 TRX would be transmitted on each of the 2 antennas per cell sector, both antennas were used for receive diversity for all TRXs
- A new antenna filter low noise amplifier variant was introduced to support dual duplexing (AFLD)



Orange 3.3 BTS introduced the Nokia DF-34 3rd generation BTS, also known as Nokia Talk-Family

NOKIA Nokia GSM/DCS 3rd Generation Outdoor BTS

Main Features

- Compact 6 TRX BTS (tri-sector or omni)
- Upgrade to 12 TRX with a second cabinet
- Lightweight aluminium cabinet for ease of installation
- Advanced features ensure efficient radio network implementation
- Receiver diversity is standard
- Central software download and remote interrogation of hardware serial numbers via O&M
- Direct connection to multi-drop and branched 2 MB transmission networks with line repeater functionality
- Integrated radio links
- Duplex filter as optional feature



6 TRX Base Station with Battery Back-up cabinet

Nokia's new GSM/DCS product family shows an in-depth understanding of the varied applications and environments which face today's network operator. The main target for the design of the new product family has been to minimize the operator's expenses like site, installation and O&M costs. The products offer the customer the freedom to plan and to deploy the network with great flexibility through the modular architecture and equipment design, which guarantee both easy initial installation and future extensions.

The Outdoor Base Station offers a medium to high capacity installation. It will support up to 6 TRX omni or 3 x 2 tri-sector in one cabinet and up to 10 TRX omni or 3 x 4 tri-sector in two cabinets. The Base Station is ideal for rooftop or rural installation, and is conveniently packaged also for indoor application.

Integrated 2 Mbit/s transmission is standard, enabling up to four transmission lines to be driven directly without additional equipment. The base station can be interfaced directly with other manufacturers' radio relay equipment or integrated with Nokia's own 18, 23 or 38 GHz microwave radios (DMR 18/23/38). Battery back-up and support for additional line terminal equipment is available in a separate cabinet, as an optional feature.

The Outdoor Base Station forms part of a complete product range which includes the ultra-compact 2 TRX Mini Base Station and the compact 6-12 TRX Indoor Base Station. These products serve a range of various indoor and outdoor applications.

Technical Data
Nokia GSM/DCS 3rd Generation Outdoor BTS

TX Frequency:	GSM	925-960 MHz (extended frequency band)
	DCS	1805-1880 MHz
RX Frequency:	GSM	880-915 MHz (extended frequency band)
	DCS	1710-1785 MHz
TX Output power:	GSM	Class 5: 20 W -0...+3 dB Dynamic power control range 30 dB in 2 dB steps
	DCS	Class 1: 20 W -0...+3 dB Dynamic power control range 30 dB in 2 dB steps in addition to 12 dB preselectable in 2 dB steps
Dimensions (HxWxD):		1.32 x 0.77 x 0.65 m (single cabinet)
Weight:	Cabinet Max.	110 kg (Min.) 315 kg
Operating temperature:		-33°C to +40°C
Capacity:		1 - 6 TRX omni (ext. up to 10 TRX) 3 x 2 TRX sectorized (ext. up to 3 x 4 TRX)
Power feed:		AC or DC

All Nokia products are subject to continuous research and development; we therefore reserve the right to alter technical specifications without prior notice.

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Libra

Nokia DF-34 BTS came in outdoor and indoor variants, each cabinet supported 6 TRX - this was a completely new generation of equipment

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DE 34/DF 34 BTS Description

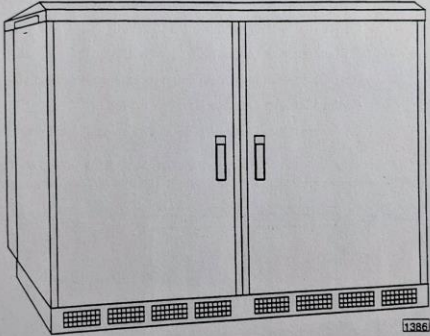
1.3. Nokia Citytalk Outdoor BTS

The Outdoor Cabinet is designed to house the GSM and DCS versions in outdoor conditions.

The Outdoor BTS can be configured as follows:

- 1 - 6 TRXs, omnidirectional.
- 2 or 3 * (1 - 2) TRXs, sectorized.
- 2 * (4 - 6) or 3 * (3 - 4) TRXs, sectorized (with an Extension cabinet).

The figure below shows the Basic cabinet equipped with an Extension cabinet.



1386

Figure 4. Outdoor Basic and Extension Cabinet

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DE 34/DF 34 BTS Description

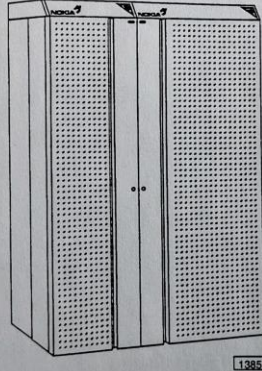
1.2. Nokia Intratalk Indoor BTS

The Indoor Cabinet is designed to house the GSM and the DCS versions in weather-guarded locations.

The Indoor BTS can be configured as follows:

- 1 - 6 TRXs, single sector.
- 2 or 3 * (1 - 2) TRX, sectorized.
- 2 * (4 - 6) or 3 * (3 - 4) TRXs, sectorized (with an Extension cabinet).

The figure below shows the Basic cabinet equipped with an Extension cabinet.



1385

Figure 3. Indoor Basic and Extension Cabinet

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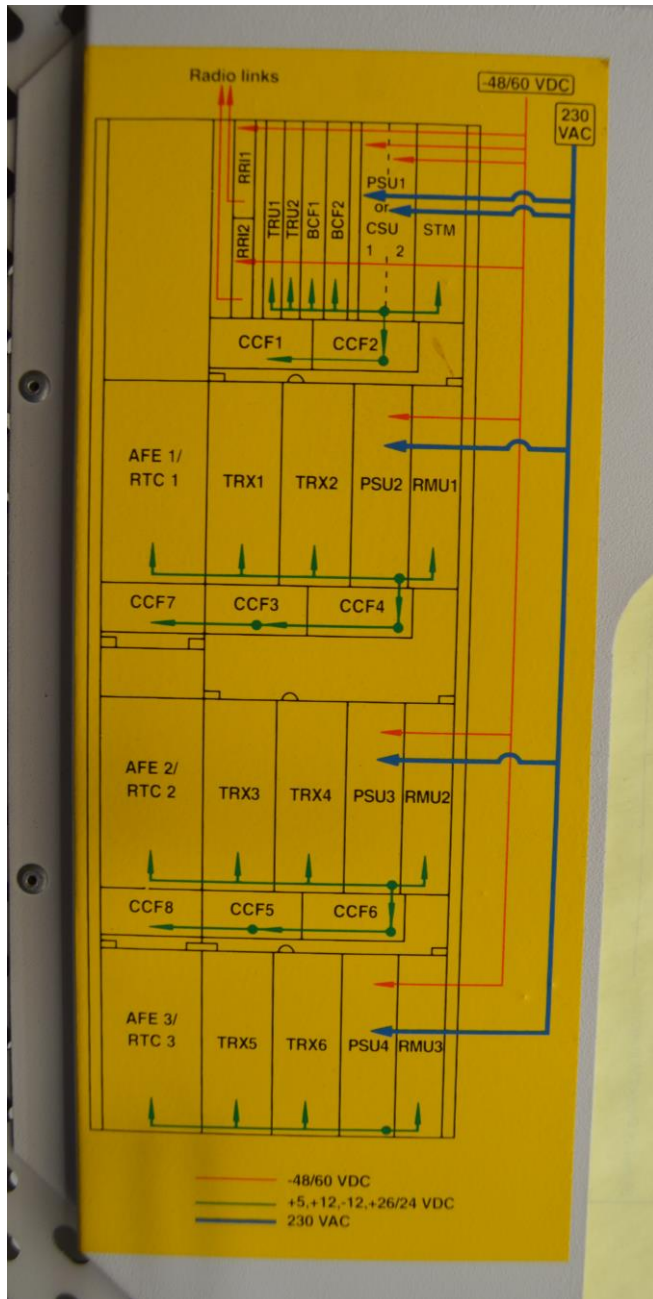
Orange 3.3 BTS - P/R & S/T racks

- The outdoor variant of the DF-34 BTS were known as P rack and R rack, a single or dual cabinet solution was common, based on the capacity required
- The indoor variant of the DF-34 BTS were known as S rack and T rack, as with the outdoor solution, a single or dual cabinet solution was common, based on the capacity required
- A single cabinet could support 6 TRXs, this could be utilised as 1, 2 or 3 cell sectors, depending on the capacity per cell sector
- A range of combiners, including remotely tuned combiners, enabled 1 to 6 TRXs to be combined to a single sector
- The 12 TRXs of the two cab/rack solution could be supported on a single 2.048Mbps E1 frame based on 16 or 32Kbps TRX signalling
- A third rack could be added to increase overall capacity to 6+6+6, this required a second E1 transmission circuits for the Abis interface - the third rack would be another P or S rack with its own Abis transmission
- As capacity demand grew Orange added more cell sectors to manage GSM traffic, while 3 cell sectors was the most common design, 1 and 2 sector sites were used and 4, 5 and 6 cell sector sites were used to manage high traffic demand
- Other operators used >6 TRX per cell sector however this was very unusual for Orange, typically 6 TRX was the maximum...



Orange 3.3 S and T racks

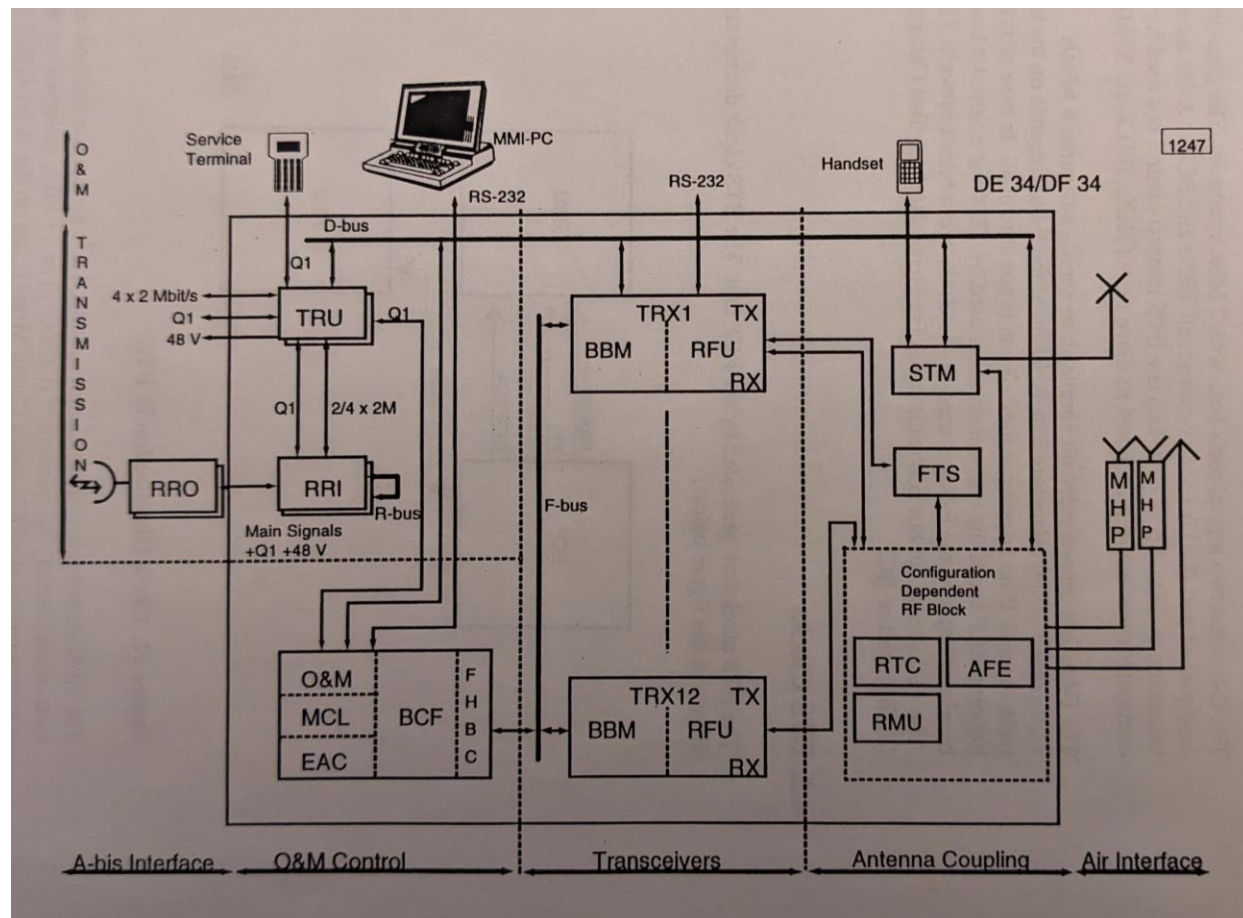
- The photo on the right is an S and T rack which formed part of a 3 rack solution on this site, enabling a maximum configuration of 6+6+6 (third rack is out of photo shot)
- The DF-34 TRX was a single unit in which the DF-12 units of TXUA, 2 X RXUA, 1x FUCB and 2 x DSPU cards were integrated into a single TRXD module, a significant optimisation which enabled a much greater capacity density



- The layout of the S rack can be seen on the yellow image to the left of this page with common cards and the transmission card for the Abis interface on the top shelf.
- TRX 1, 2, 3, 4, 5 & 6 are installed in the 3 lower shelves, along with power supplies and RF combining
- The T rack, seen on left side of image to the right, is sub-tended off the S rack which can support a maximum of 12 TRXs on the Abis interface
- An Orange site with 6+6+6 configuration would be provisioned with 2 x E1 Abis interface circuits, one would be fully utilised while the 2nd would be partially (50%) utilised



Nokia DE-34/DF-34 BTS block diagram



- TRU - Transmission Unit
- O&M - Operations and Maintenance Unit
- MCL - Master Clock (Synchronisation)
- EAC - External Alarm Card
- BCF - Base Control Function
- FHBC - Frequency Hopping Control
- TRX - Transceiver, which consists of BBM - Baseband Module and RFU - Radio Frequency Unit
- STM - Site Test Monitor Unit
- FTS - ???
- AFE - Antenna Filter Unit
- RTC - Remote Tuned Combiner
- RMU - Receive Multi-coupler Unit
- MHP - Mast Head Pre-amp
- RRO - Radio Relay Outdoor unit & RRI - Radio Relay Indoor unit refer to Nokia's optional integrated microwave radio backhaul solution, this wasn't implemented by Orange

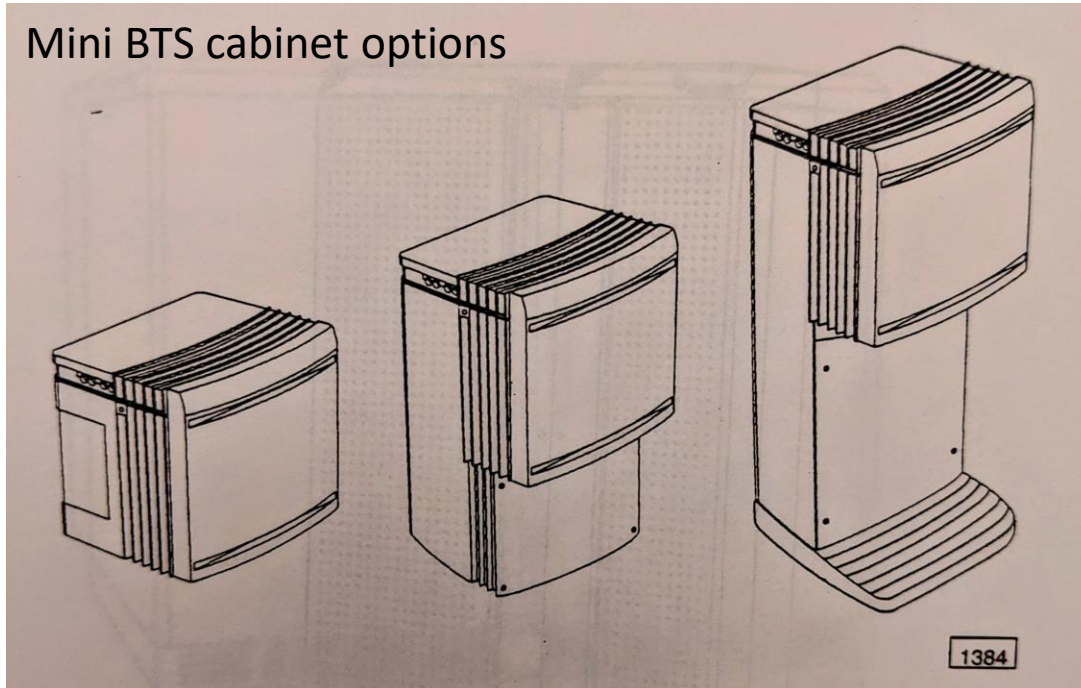
Nokia Mini BTS

Nokia Flexitalk Mini-BTS could be installed either in indoors or outdoor environments, on a wall mounted bracket or on a free-standing plinth for example, in offices, shopping centres or tube stations.

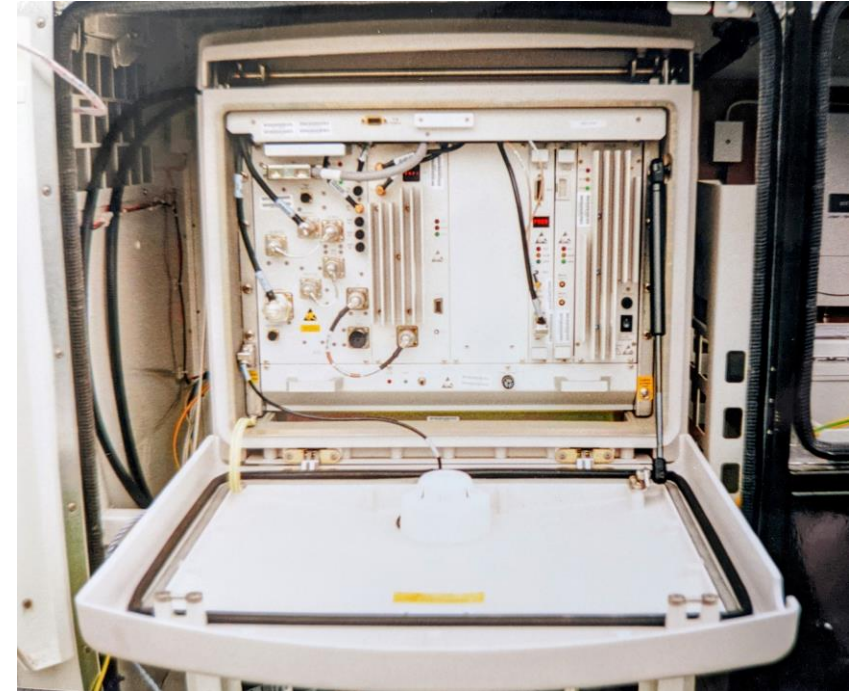
The Mini BTS could be configured as 1 or 2 TRX in a single cell sector

The outdoor variant had a heat exchanger unit installed in the lower part of the cabinet

Mini BTS cabinet options



Indoor wall mounted - outdoor wall mounted - indoor plinth mounted



Orange installation with 1 DCS/GSM1800 TRX installed
In this configuration the BTS would have required the following Abis interface transmission capacity:

- 128kbps for traffic channels (8 x TDMA timeslots)
- 32kbps for TRX signalling link
- 64kbps for O&M signalling link
- Total Abis backhaul capacity of 224kbps
- This would increase to 384kbps when 2nd TRX was added

Nokia Mini BTS



Nokia GSM/DCS 3rd Generation Mini BTS



Main Features

- Compact and highly integrated 2 TRX BTS for GSM and DCS networks
- Advanced features ensure the cost efficiency of the network
- Wide range of indoor and outdoor installation environments (rooftop, shopping centers, road side, office etc.)
- Central software down-load and remote interrogation of hardware serial numbers via O&M
- Built in support for multi-drop and branched 2 MB transmission networks with line repeater functionality
- Supports the microcell network concept
- 1st product of the Nokia 3rd generation BTS family

Nokia has a proven track record of delivering infrastructure equipment for cellular networks. Through its long term presence and co-operation on the global market, Nokia has a good understanding of the customer's different environments and

varying needs. Based on this experience, Nokia has now created new dimensions for GSM/DCS base stations. The main target for the design of the new product family has been to minimize the operator's expenses like site, installation and O&M costs.

The Mini Base Station offers the customer the freedom to plan and to deploy the network with great flexibility. The Nokia Mini Base Station is small enough to be unobtrusive but is attractively styled.

Technical data

Nokia GSM/DCS 3rd Generation Mini BTS

TX Frequency:

GSM	925-960 MHz (extended frequency band)
DCS	1805-1880 MHz

RX Frequency:

GSM	880-915 MHz (extended frequency band)
DCS	1710-1785 MHz

TX Output power:

GSM	Class 5: 20 W -0...+3 dB
	Dynamic power control range 30 dB in 2 dB steps
DCS	Class 1: 20 W -0...+3 dB
	Dynamic power control range 30 dB in 2 dB steps in addition to 12 dB pre-selectable in 2 dB steps

Dimensions (HxWxD):

0.51 x 0.59 x 0.47 m

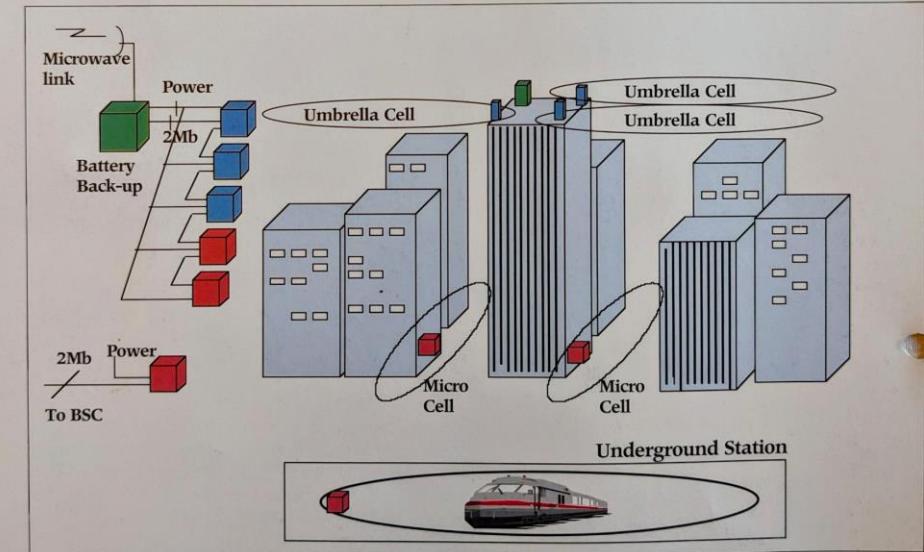
Weight:	Cabinet	43 kg (+10 kg outdoor)
	Max.	78 kg (+10 kg outdoor)

Operating temperature:

-5°C to +45°C
-33°C to +40°C (outdoor)

Capacity: 1-2 TRX omni

Power feed: AC



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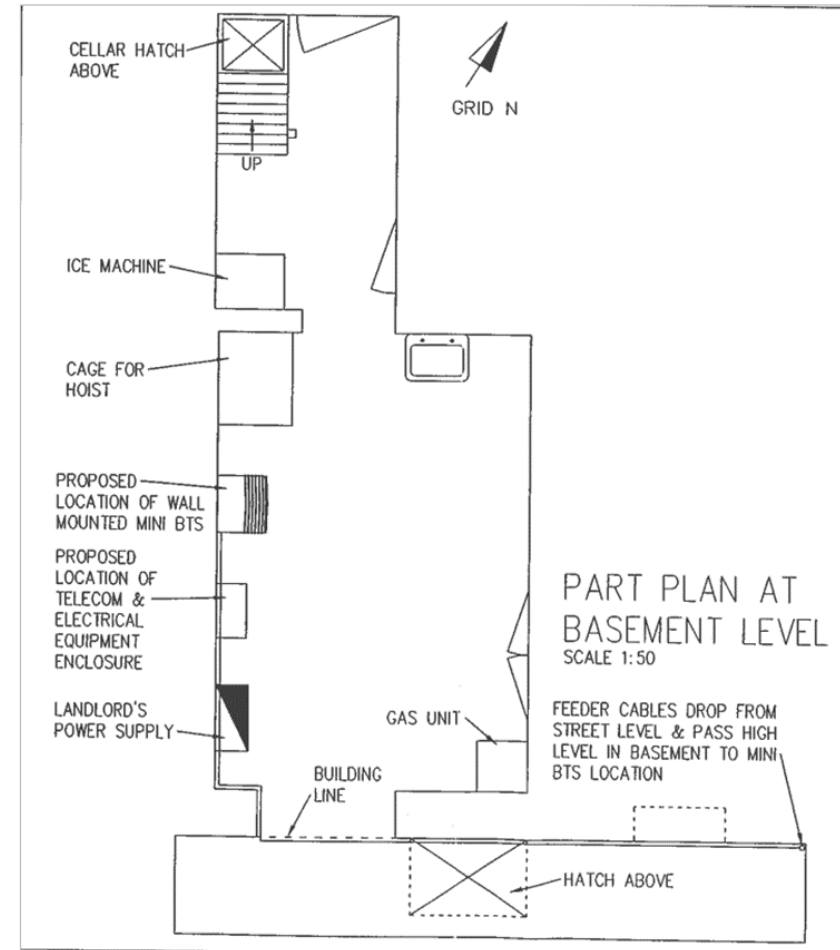
Orange deployments of Nokia Mini BTS



- Nokia Mini BTS deployed in Orange street cabinet with lamppost style antenna mounting structure - often referred to as street-works site nowadays...
- Deployed in 1 x TRX configuration, Mini-BTS could be upgraded to 2 x TRX as capacity demand increased
- Abis transmission connected via BT leased line, an n x 64kbps circuit which was aggregated with other n x 64kbps circuits to ensure a reasonable fill rate on the BSC 2.048Mbps (E1) ET card
- Enough capacity would have been reserved on the aggregation E1 bearer to allow this site to be upgraded to 2 x TRX as and when capacity demand required it
- While the Mini-BTS is a single cell sector, the configuration in the photo shows RF splitters in the base of the cabinet, 1 for Tx/Rx and the second for diversity Rx
- The splitters have three antenna side inputs/outputs connected and as such this indicated that three cell sectored antennas are installed on the lamppost/column
- The use of this technique was known in Orange as SST - Simultaneous Sectored Transmission - this approach offered enhanced antenna gain versus an omni directional antenna but would have suffered from serious nulls at the intersection between antenna patterns, due to interference as the sectors were connected to the single cell TRX(s)
- This type of micro cell was designed to provide a small amount of coverage in-fill, and/or a capacity uplift within the local area. The coverage requirement would typically be minimal...

Orange deployment of Nokia Mini BTS

This is a micro cell deployment which provided additional capacity to the local area via a 2 x TRX base station (Nokia Mini-BTS) and a single cell sector with indoor mounted Nokia Mast Head Amplifiers (receiver pre-amps) and a small dual polarized 1800 MHz antenna



Summary

- Orange Class 3.x BTS was built around the Nokia DF-12 and DF-34 products, these BTS enclosures were deployed alongside an Orange TXC (transmission cab) which housed the power supply, rectifiers and batteries plus the Abis transmission backhaul, typically a point-to-point microwave radio
- Micro cells designs varied depending on whether they were street-side lamppost sites or in-building solution - providing primary coverage and capacity either indoors or outdoors
- Variants of the Orange Class 3 (DF-12) macro cell BTS were in use from pre-launch rollout through until 10th January 2005
- Nokia's Ultra-site BTS was adopted as the default platform post DF-34, proving a significant uplift in capacity - a future briefing will cover this...
- A significant number of DF-34 installations remained beyond this date, some of these remained operational until the integration activities between Orange and T-Mobile, typically being swapped out in the 2012 to 2016 timeline

