Information regarding Bluetooth is subject to change without notice.

WHO IS/WAS BLUETOOTH?

Harald Blaatand

- Viking and King of Denmark 940-981
  - **Son of Gorm the Old (King of Denmark) and**
  - **Thyra Danebod (daughter of King Ethelred of England)**
  - **Harald united and controlled Denmark and Norway**

Harald Blaatand "Bluetooth" II

- The modern viking
- This is one of two Runic stones erected in his capital city of Jelling (central Jutland)
  - **This is the front of the stone depicting the chivalry of Harald**
  - **Harald thinks mobile PCs and cellular phones should seamlessly communicate**

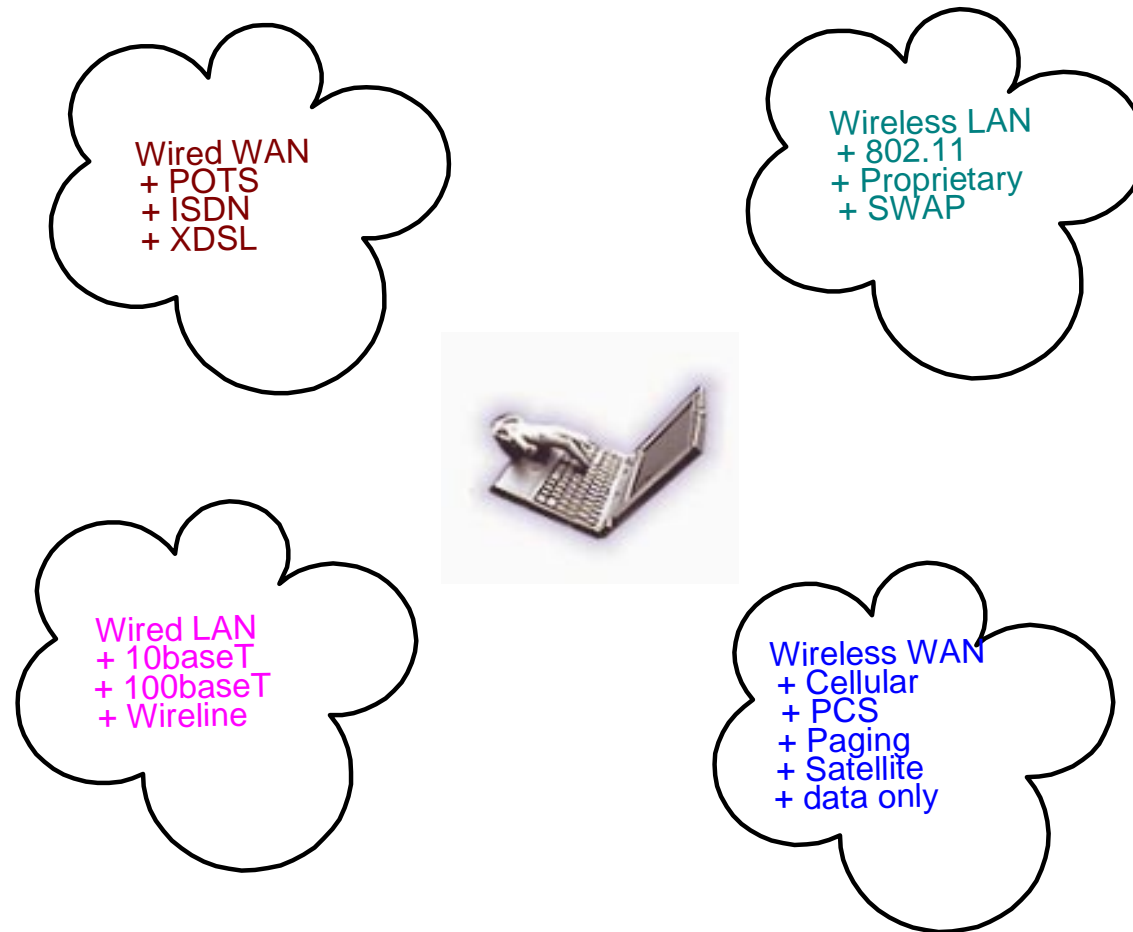Information regarding Bluetooth is subject to change without notice.

BLUETOOTH OBJECTIVE

Wireless link between all mobile devices

Information regarding Bluetooth is subject to change without notice.

NEW FREEDOM AND ENDLESS POSSIBILITIES

- **Universal mobile connectivity**
- **Ultimate synchronicity**
- **. . . without wires**

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BLUETOOTH AS A STANDARDS BRIDGE

Wired WAN
+ POTS
+ ISDN
+ XDSL

Wireless LAN
+ 802.11
+ Proprietary
+ SWAP

Wired LAN
+ 10baseT
+ 100baseT
+ Wireline

Wireless WAN
+ Cellular
+ PCS
+ Paging
+ Satellite
+ data only

Bluetooth can provide a single standard to bridge many international standards.

Bluetooth

Information regarding Bluetooth is subject to change without notice.

BLUETOOTH DATA FORMAT

- **A combination of circuit and packet switching is used**

- **Synchronous channels can be set up and slots can be reserved for these channels. They are used for voice.**

- **Asynchronous channels are used for non-voice data transfer**

- **Bluetooth can support an asynchronous data channel (ACL) and up to 3 simultaneous synchronous voice channels (SCO), or a channel that simultaneously supports asynchronous data and synchronous voice.**

TECHNICAL SUMMARY

- **2.4 GHz ISM Open band**
    - **Globally free available frequency, 89 MHz of spectrum available**
- **10 -100 m range, personal bubble**
    - **8 active devices per piconet (share data rate)**
    - **Up to 10 piconets in bubble (full data rate)**
- **1 Mbps gross rate**
    - **Future version: 2-11 Mbps**
- **Simultaneous voice/data capable**
    - **432 Kbps (full duplex), 721/56 Kbps (asymmetric)**
    - **or**
    - **3 simultaneous full duplex voice per piconet (CVSD@64 Kbps).**
    - **or a combination of data and voice**

Bluetooth

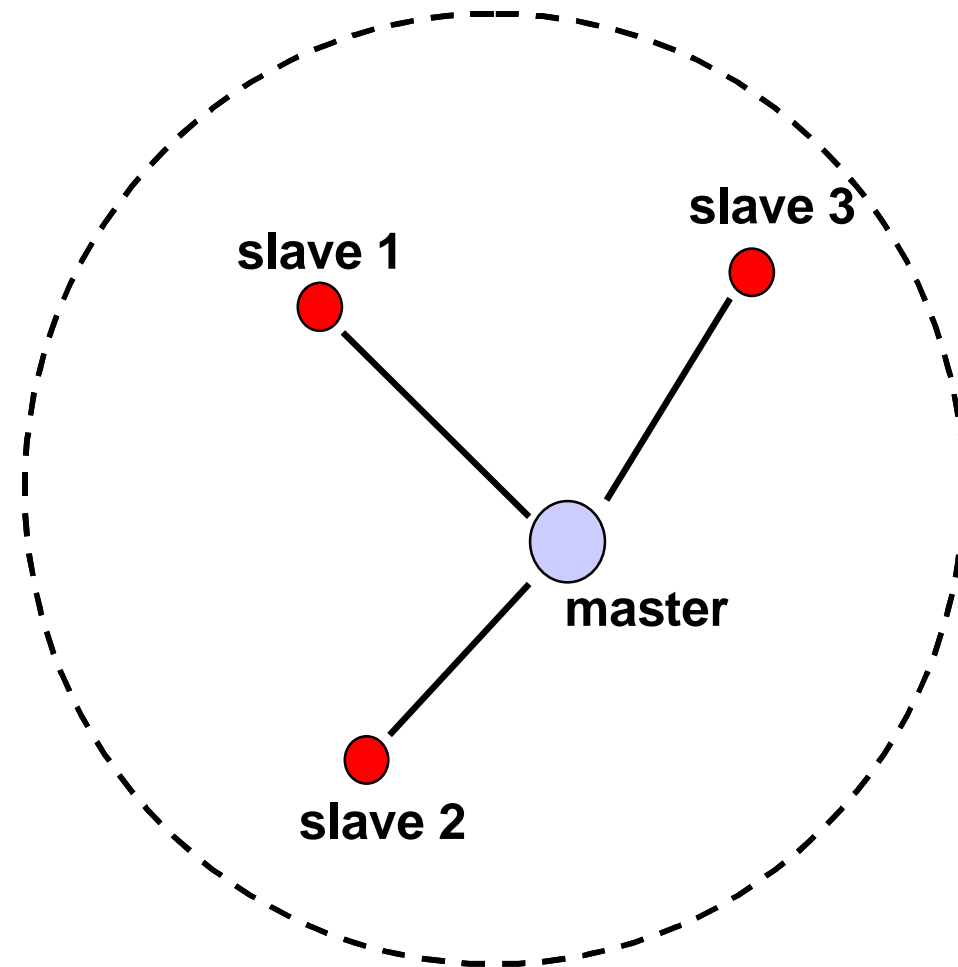Information regarding Bluetooth is subject to change without notice.
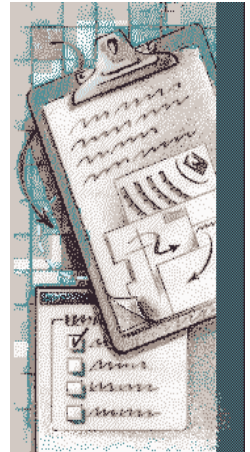
NETWORKING

- **Two or more units sharing the same channel form a PICONET**

- **One unit acts as the MASTER, the others act as SLAVES. Up to seven Slaves can be active on a Piconet**

- **Up to 200+ more slaves can remain locked to the master in a PARKED state.**

- **Each Piconet can only have one master but slaves can participate in different Piconets on a Time Division Multiplex (TDM) basis.**

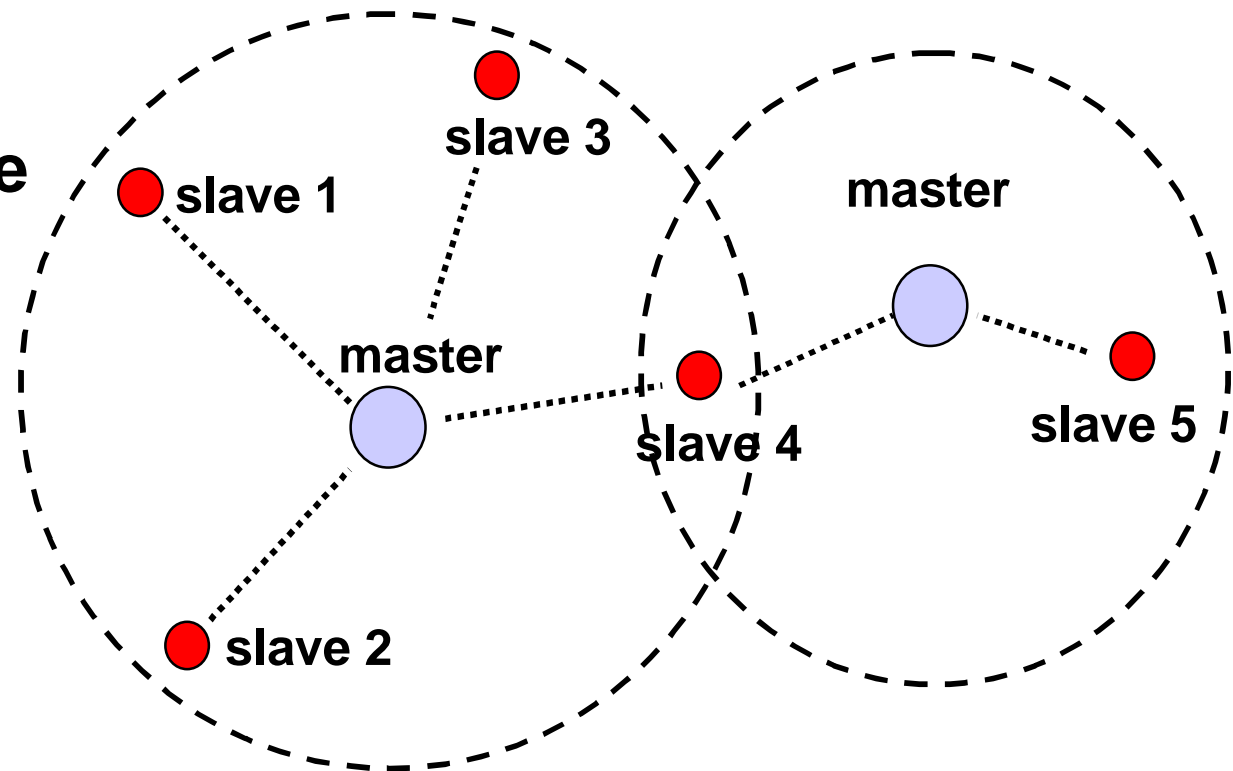- **A Master in one Piconet can be a Slave in another**

Bluetooth

Information regarding Bluetooth is subject to change without notice.

PICONETS

- **Master can connect to 7 simultaneous or 200+ active slaves per piconet**

- **Unique hopping pattern/ID for each piconet**

slave 1

slave 3

master

slave 2

Information regarding Bluetooth is subject to change without notice.

SCATTERNETS

- **Multiple Piconets with overlapping coverage form a SCATTERNET**

- **Radios can share piconets**

slave 3

slave 1

master

slave 4

master

slave 5

slave 2

Information regarding Bluetooth is subject to change without notice.

THE BLUETOOTH RADIO INTERFACE

- **Industrial Scientific Medical (ISM) frequency band.**

- **79 channels, 2.402 - 2.480 GHz (in Europe).**

- **1600 channel hops/s.**

- **Gaussian Frequency Shift Keying (GFSK).**

- **Frequency deviation: 140 - 175 kHz.**

Power

2.4 GHz   2.5 GHz

Frequency

Frequency

+160 kHz

-160 kHz

Time

Data: 101110100000110100110

Bluetooth

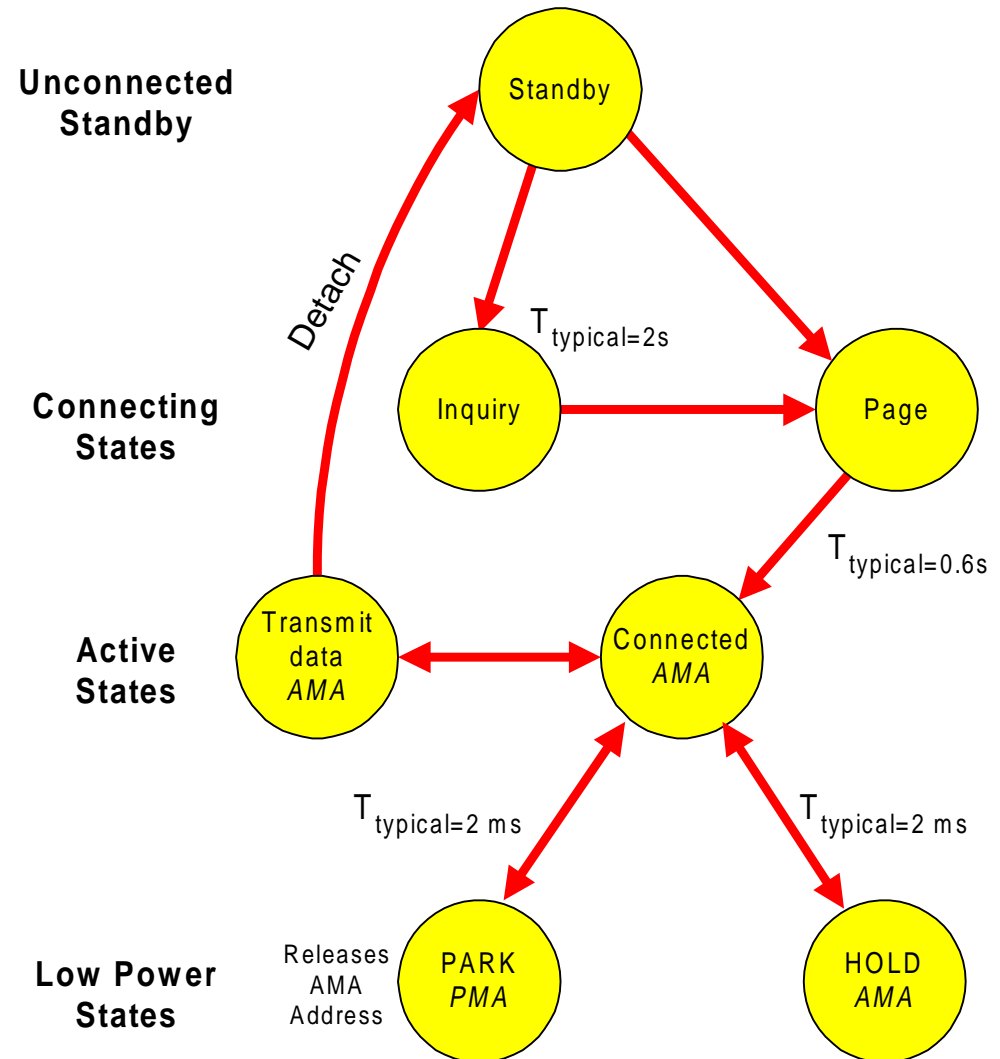Information regarding Bluetooth is subject to change without notice.
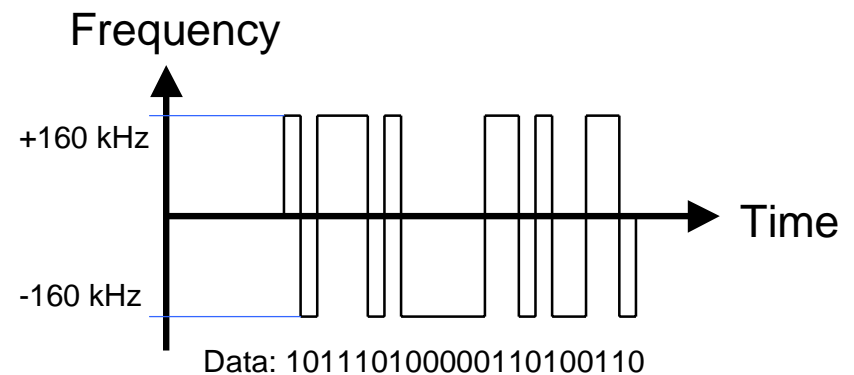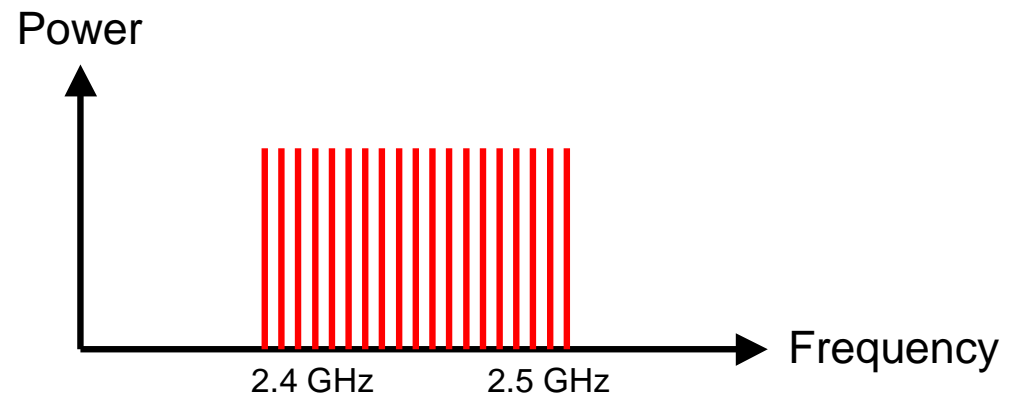
FREQUENCY BANDS AND ARRANGEMENT OF CHANNELS

- **In the USA and Europe the 79 channels run from 2402 MHz to 2480 MHz. There is a 2 MHz guard band at the low frequency end and a 3.5 MHz guard band at the upper end.**

- **France, Spain and Japan are the exceptions, they have only 23 channels and different guard bands and RF channels are defined in each country.**
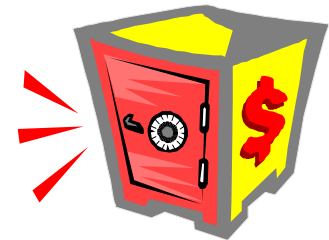
Information regarding Bluetooth is subject to change without notice.

CONNECTION STATES

- **<u>Standby</u>**
  - **Waiting to join a piconet**
- **<u>Inquire</u>**
  - **Finding devices**
- **<u>Page</u>**
  - **Connect to a known device**
- **<u>Connected</u>**
  - **Actively on a piconet (master or slave)**
- **<u>Park/Hold</u>**
  - **Low Power connected states**

Unconnected Standby

Standby

Detach

$T_{typical=2s}$

Connecting States

Inquiry   Page

$T_{typical=0.6s}$

Active States

Transmit data *AMA*   Connected *AMA*

$T_{typical=2\,ms}$ $T_{typical=2\,ms}$

Low Power States

Releases AMA Address

PARK *PMA*   HOLD *AMA*

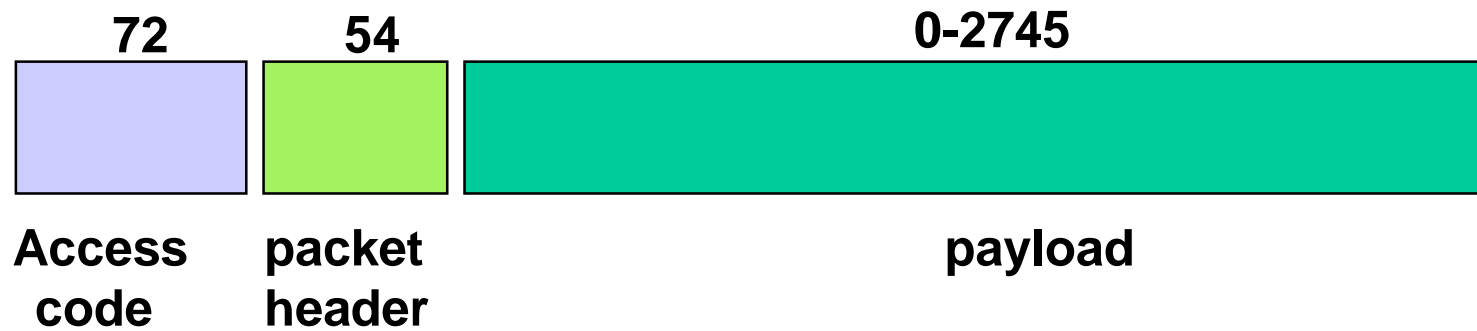Information regarding Bluetooth is subject to change without notice.

BLUETOOTH SECURITY

- **Provides link layer security between any two Bluetooth radios**
- **Authentication (E1 algorithm)**
  - **Challenge/Response system**
- **Encryption (privacy)**
  - **Encrypts data between two devices**
  - **Stream cipher with E0 algorithm**
- **Key management and usage**
  - **Configurable Encryption key length (0-16 bytes)**
  - **Key generation with E2-E3 algorithms**

Bluetooth

Information regarding Bluetooth is subject to change without notice.

BLUETOOTH PACKET FORMAT

72	54	0-2745
Access code	packet header	payload

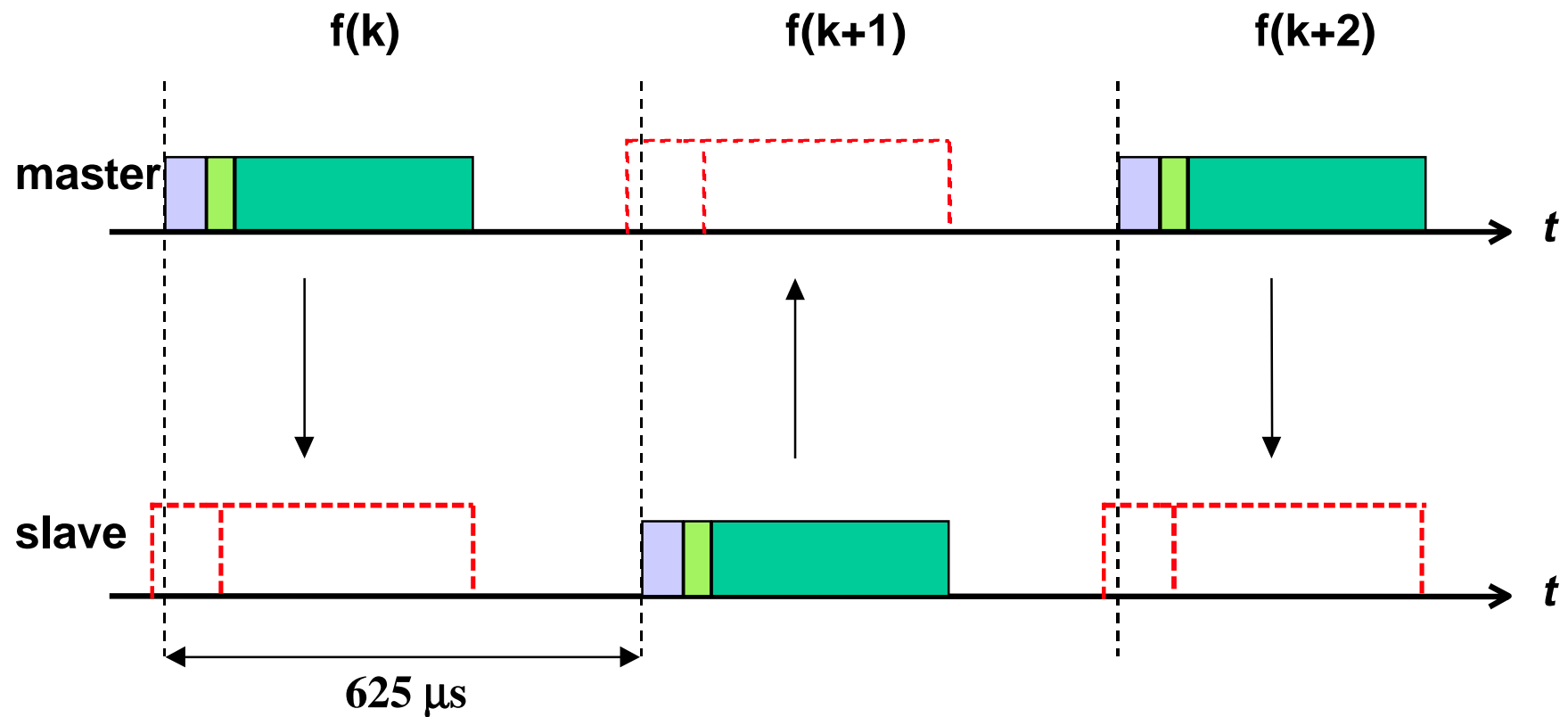Information regarding Bluetooth is subject to change without notice.

Bluetooth

SINGLE SLOT PACKETS

- The master starts transmitting in even numbered timeslots only, the slaves in odd timeslots only.

f(k)   f(k+1)   f(k+2)

master

slave

t

t

625 μs

Information regarding Bluetooth is subject to change without notice.

PACKET TYPES AND DATA RATES

Data Rates (Kbps)

TYPE	symmetric	asymmetric	
DM1	108.8	108.8	108.8
DH1	172.8	172.8	172.8
DM3	256.0	384.0	54.4
DH3	384.0	576.0	86.4
DM5	286.7	477.8	36.3
DH5	432.6	721.0	57.6

Information regarding Bluetooth is subject to change without notice.

THE ERICSSON BLUETOOTH RADIO MODULE

- **Multi-layer LTCC substrate (Low Temperature Co-fired Ceramics).**
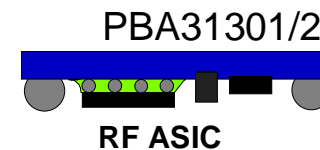- **Integrated functionality in the substrate:**
    - **Antenna filter**
    - **Baluns**
    - **Switch**
- **Handled in panels.**
- **Laser scribed.**

Information regarding Bluetooth is subject to change without notice.
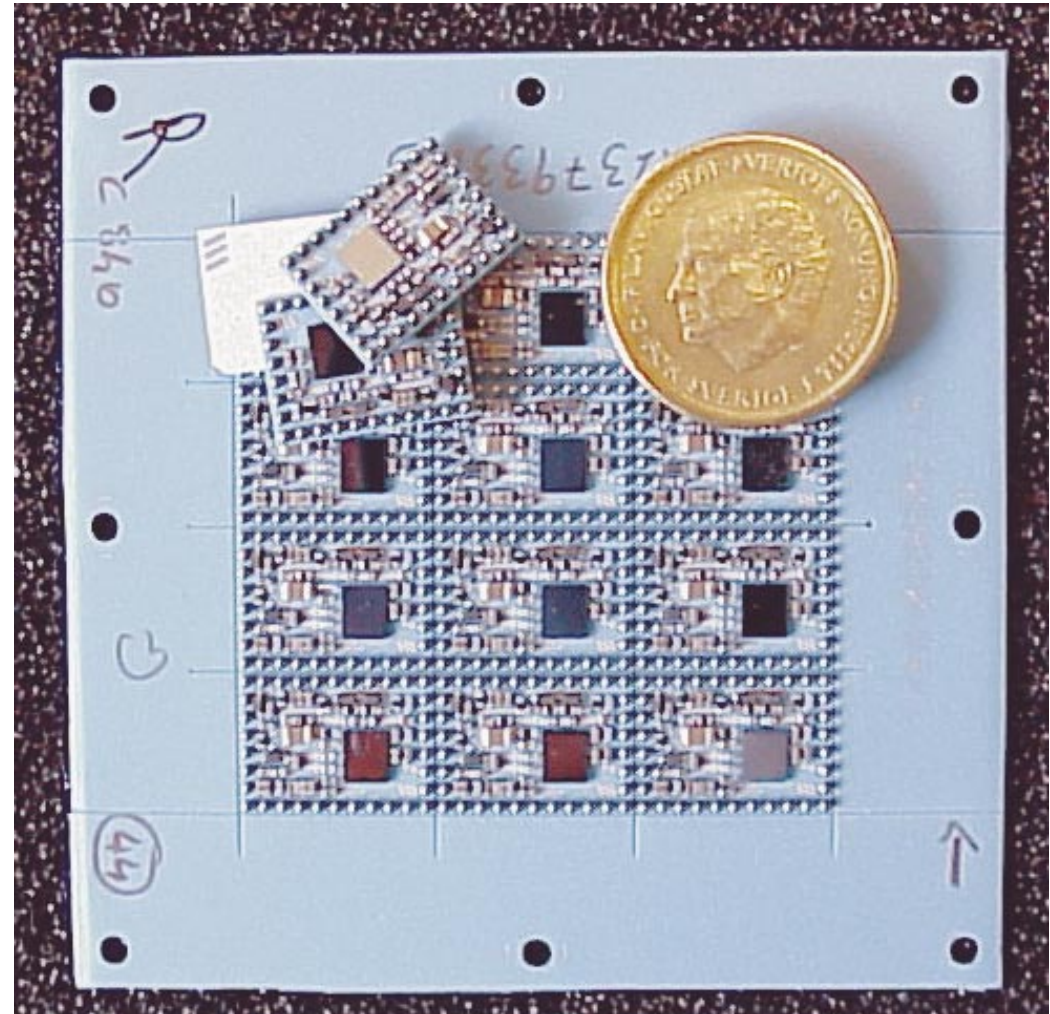
RADIO MODULE FEATURES

- Multilayer ceramic substrate (LTCC)
  - 40 Integrated passive components
    - RX / TX balun
    - Antenna filter & Switch
    - VCO tank
- Flip chipped radio ASIC.
- Discrete components
  - 30 passive components
- Length   typ 13,7 - 14,3 mm
- Width   9,7 - 10,3 mm
- Height   max 1,6 mm

PBA31301/2

RF ASIC

Information regarding Bluetooth is subject to change without notice.

LOW COST PRINCIPLES

- Single chip
- Few external components
- Main-stream technology
- Time-division duplex

external components

PIFA antenna

Bluetooth

Information regarding Bluetooth is subject to change without notice.
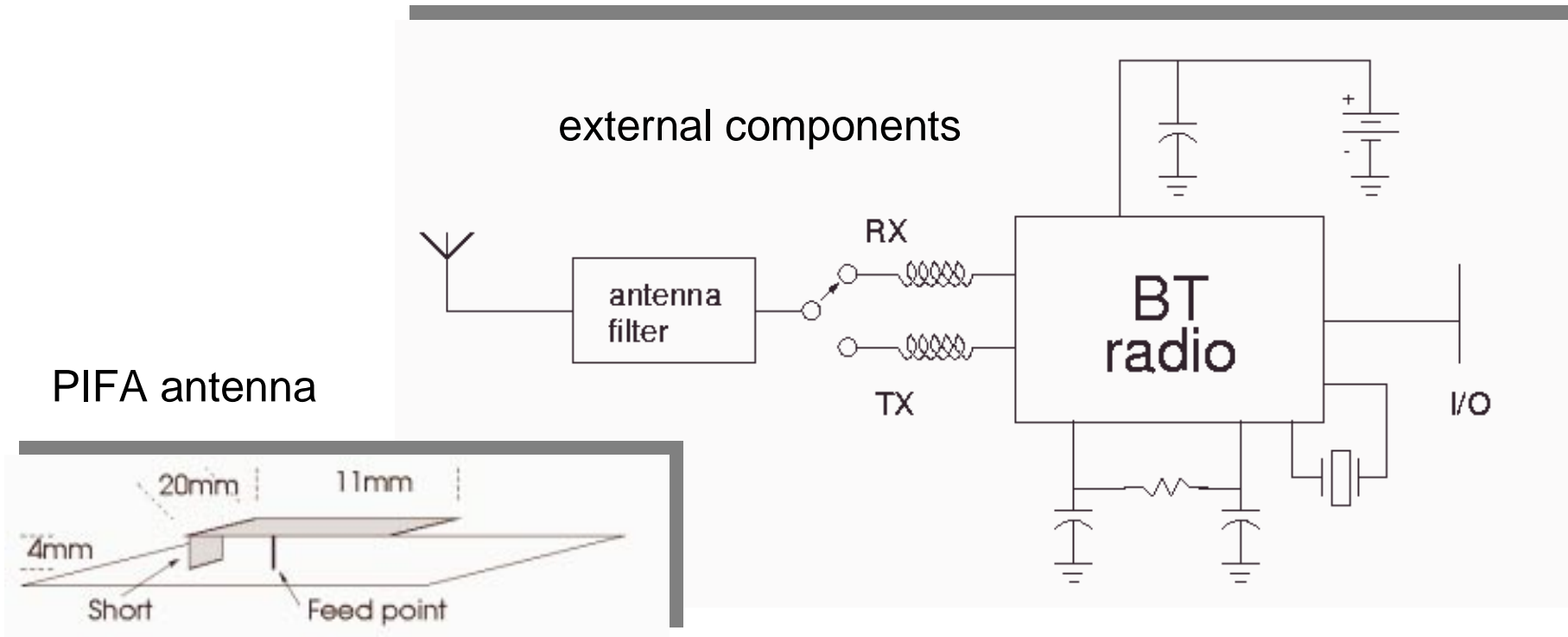
THE ERICSSON COMPLETE BLUETOOTH BASEBAND/RADIO MODULE

Serial

Interfaces

Flash Memory

VCO

RX Balun

PBA31301/2

Baseband ASIC

Radio ASIC

Antenna Filter

Power

Crystal

TX Balun

Antenna Switch

Digital Interface   Radio

Bluetooth

Information regarding Bluetooth is subject to change without notice.
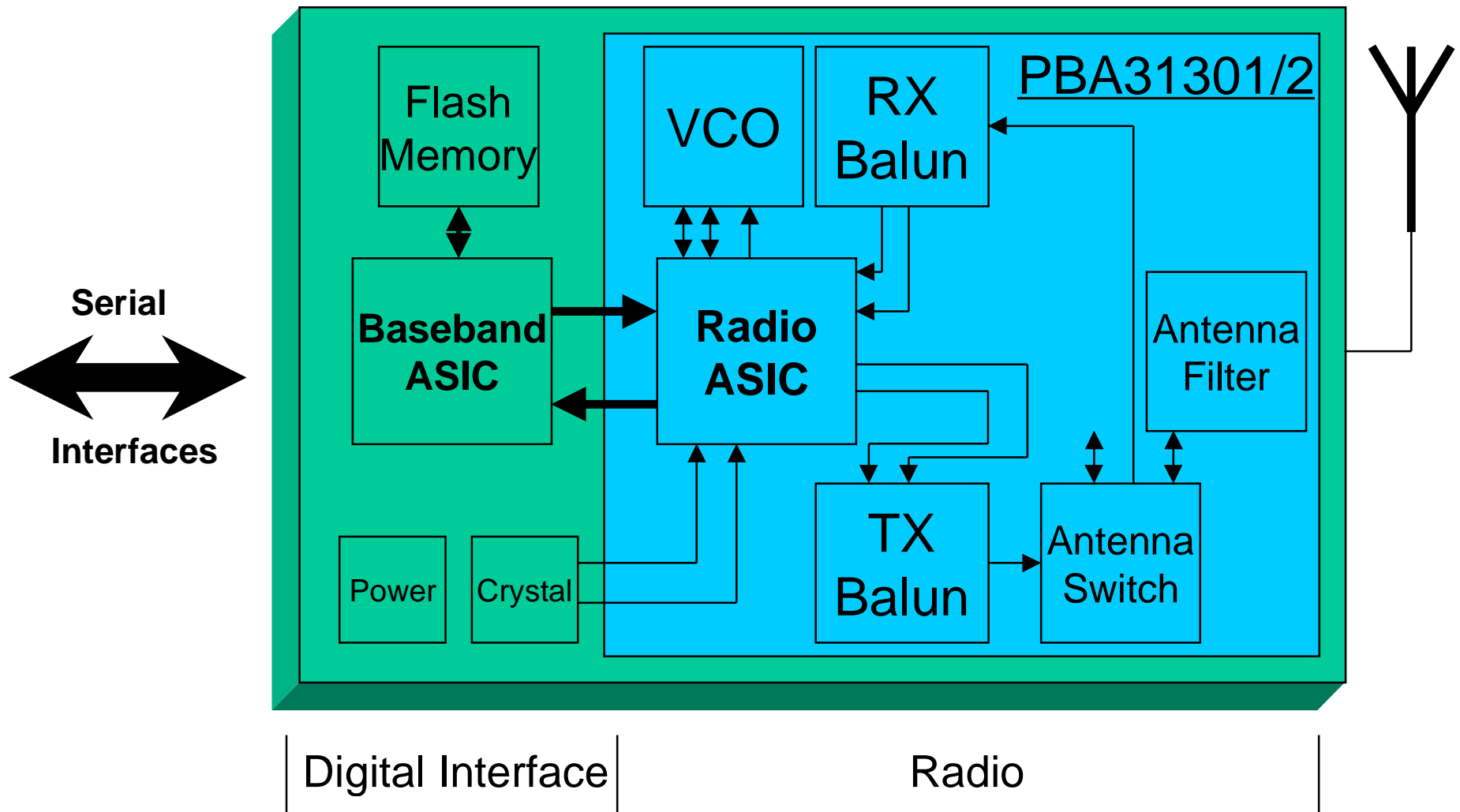
BASEBAND ASIC BLOCK DIAGRAM

Features

- 3 UART's

- USB

- IRDA

- I2C

- PCM

- JTAG

- ARM-7 CPU

Information regarding Bluetooth is subject to change without notice.

THE BLUETOOTH PROTOCOL STACK

Bluetooth

Information regarding Bluetooth is subject to change without notice.
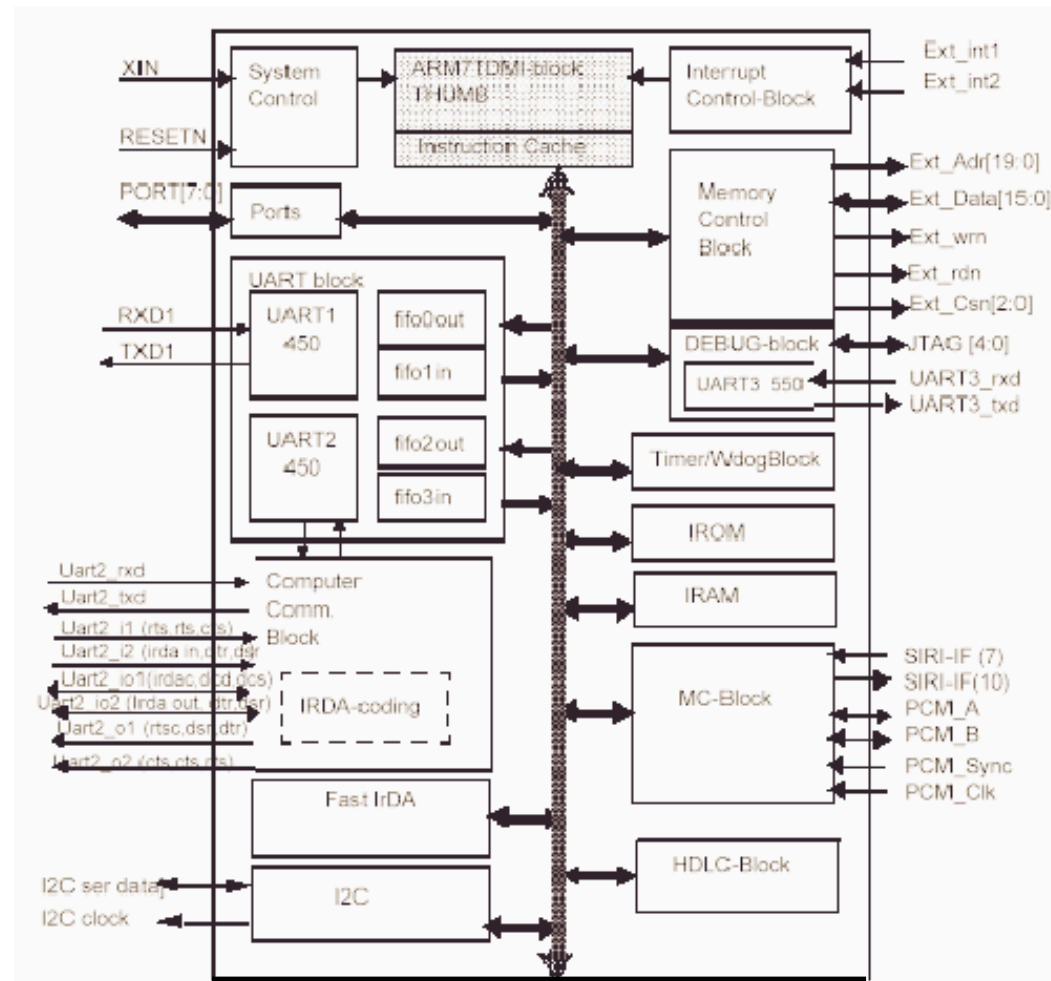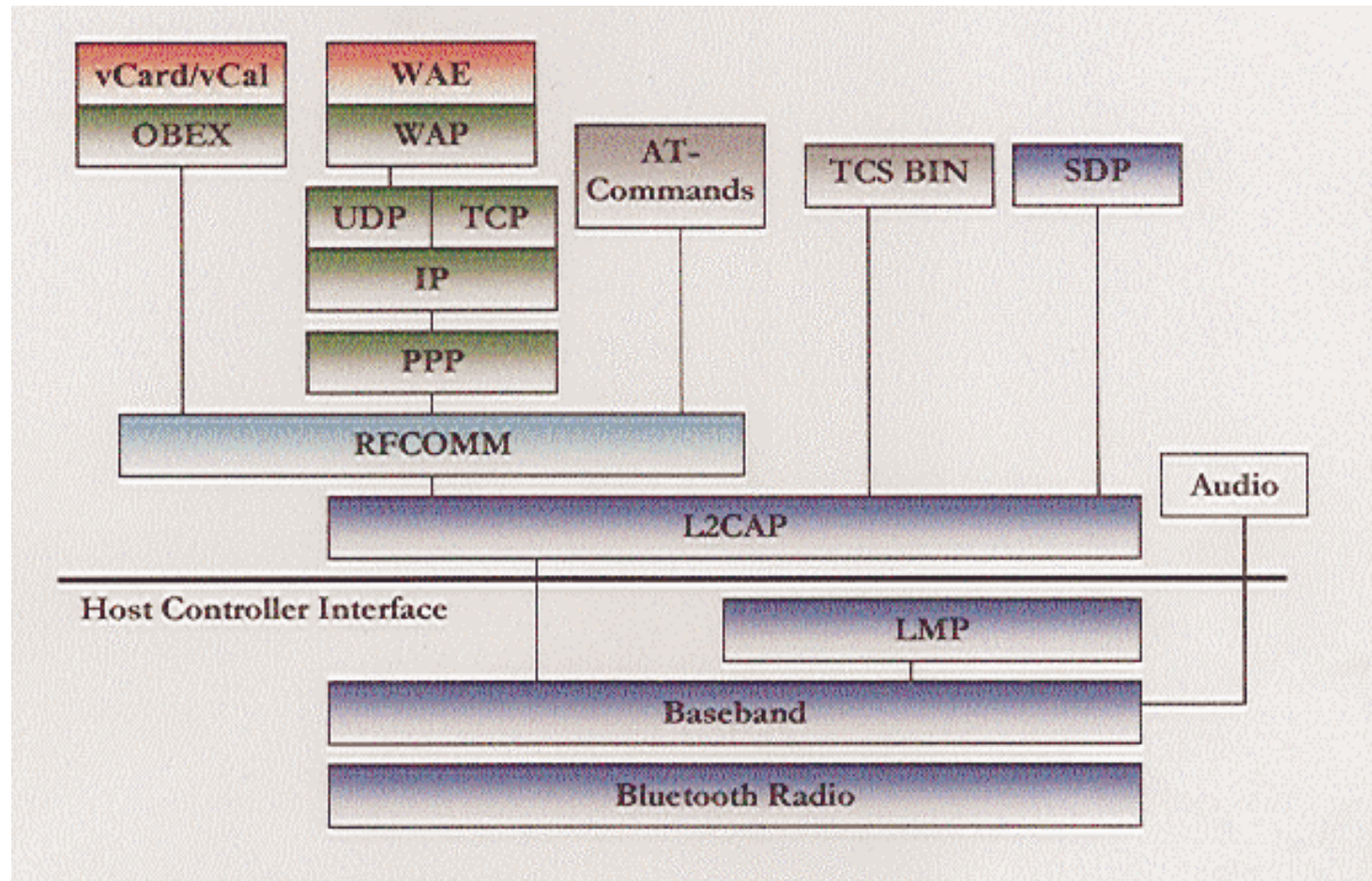
COMMUNICATION ON RS232 AND USB

- ● **Command Packets**
  - – **Used to send commands to the Bluetooth Host Controller from the Host**
- ● **Event Packets**
  - – **Used by the Host Controller to notify the Host when various events occur**
- ● **Data Packets**
  - – **Used to exchange data between the Host and Host Controller**

Bluetooth Host

Host Drives and Applications

Bluetooth HCI driver

Commands **Events** **Data**

Bluetooth Host Controller

Link Manager

Bluetooth Baseband & Link Controller

Bluetooth Radio

Bluetooth Module

Information regarding Bluetooth is subject to change without notice.
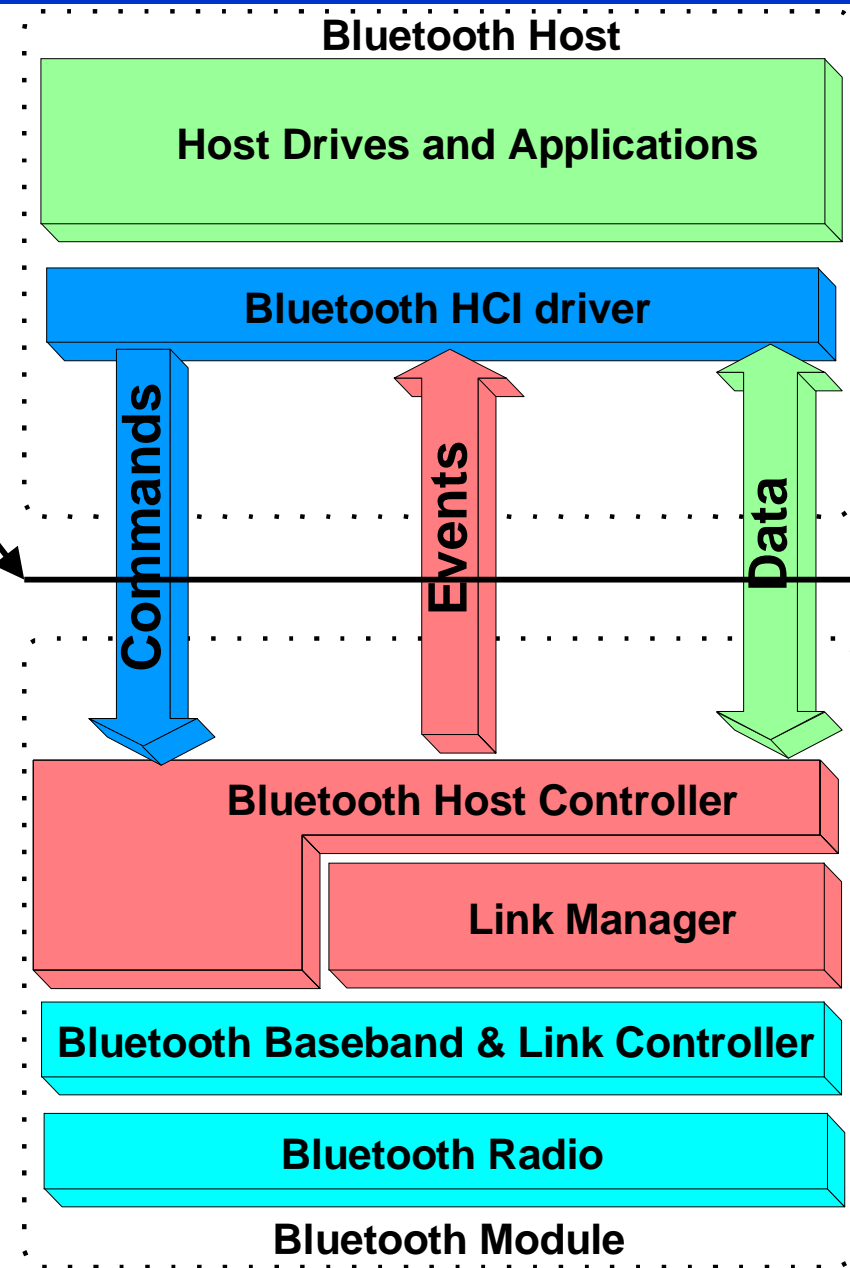
COMPLETE BLUETOOTH MODULE SUMMARY

Key Features

- FCC type approved

- Interface through USB, UART or PCM

- Bluetooth 1.0 pre-certified

- USB 1.1 compliant (Voice and Data)

- Small size, 33x17x3.36 mm

- Generic SW (HCI, L2CAP, RFCOMM)

Information regarding Bluetooth is subject to change without notice.

Bluetooth

CHIPSET INTERFACES

VCC (2.70 - 3.00 Volt) 2.75V

VCC-Core (1.60 - 2.75 Volt) 1.8V

1. System Ctrl-IF

POR_EXT

SYS_CLK
SYS_CLK_REQ

BASEBAND ASIC

ARM7TDMI

FLASH 1M*16

ADDR(0:19)

DATA(0:15)

EXT_CSN0
EXT_WRN
EXT_RDN

2. HCI(Uart /USB)

TX /USB+   UART1_TXD
RX /USB-   UART!_RXD

3. HCI(Uart)

UART2
6

4. PCM-Voice IF

PCMCLK,DAT;IN;OUT

EBC
Ericsson Bluetooth Core

POR_EXT
RESET

SYS_CLK

SYS_CLK_REQ

PBA31301/2

TX_CLK
LPO_CLK

SI_CDO
SI_CDI/CLK/CMS

RF ASIC

PHD_OFF
PX_ON
SYNT_ON
TX_ON
RX_ON

RX_DATA
TX_DATA

ANT

JTAG ARM7TDMI
ICE 5 pins

Information regarding Bluetooth is subject to change without notice.

<u>ERICSSON BLUETOOTH DEVELOPMENT KIT (EBDK</u>)
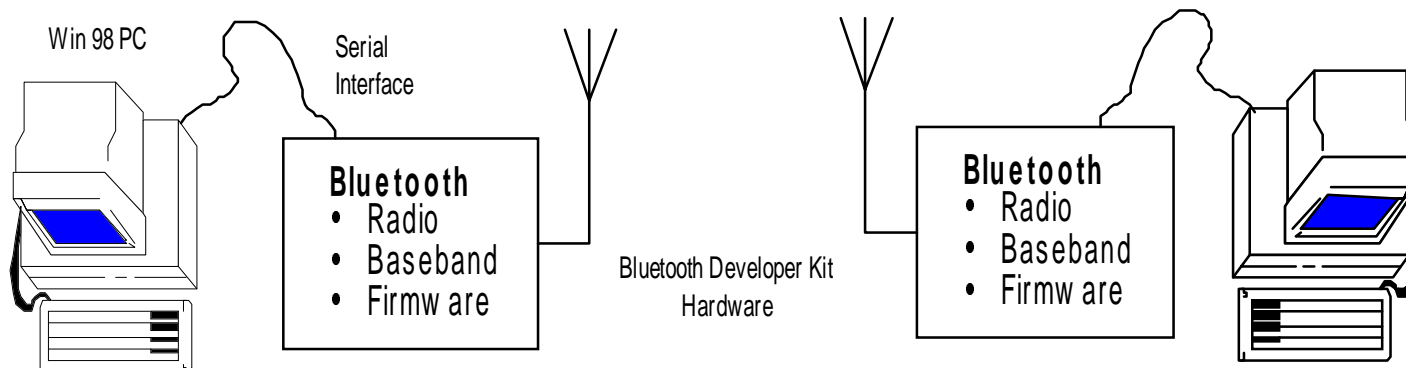
- **Demonstrator of the Bluetooth technology**

- **Starter kit for product development**

- **Application software development platform**

Win 98 PC

Serial
Interface

Bluetooth
- Radio
- Baseband
- Firmware

Bluetooth Developer Kit
Hardware

Bluetooth
- Radio
- Baseband
- Firmware

Information regarding Bluetooth is subject to change without notice.

Voltage regulators

Headset connector

Codec

USB

RS232

Baseband board

Irma

Flash

Radio board

Antenna

FPGA

Information regarding Bluetooth is subject to change without notice.

APPLICATION EXAMPLE

- **Example voice and data application supplied for Windows '98 PC**
- **Voice connected through handset on developer kit**
- **File transfer data application**
- **Demonstrates usage of module interface specification**
- **Shows message transfer between application and module**

Bluetooth application

Bluetooth application

Win 98 PC

Win 98 PC

RS 232

RS 232

Handset

Handset

bluetooth master
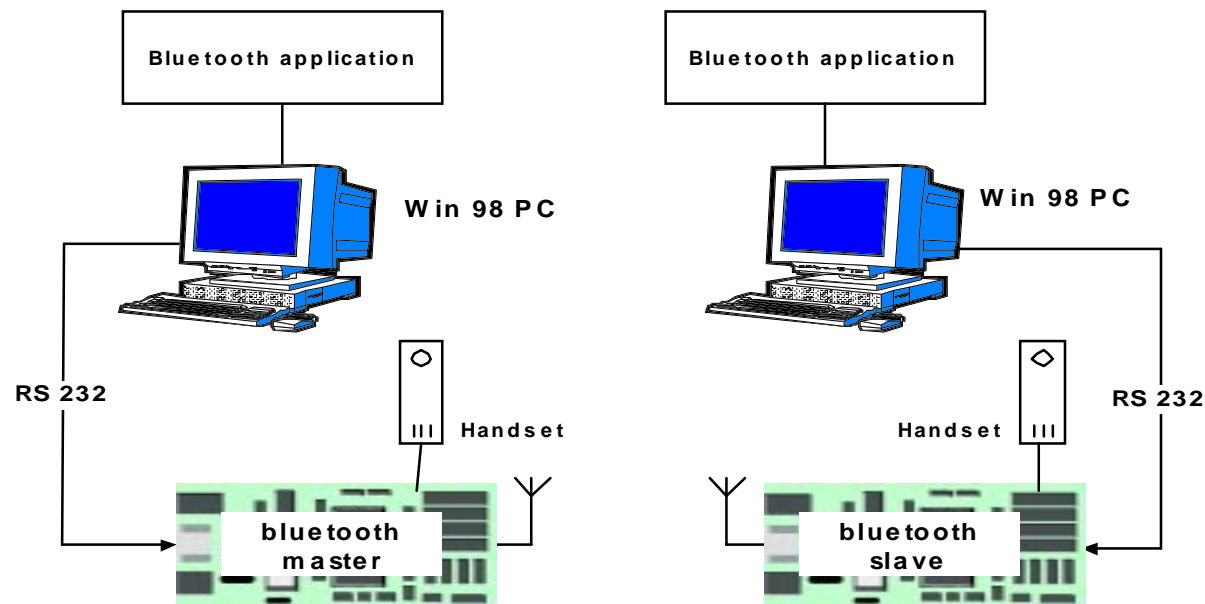
bluetooth slave

Bluetooth application example

Bluetooth

Information regarding Bluetooth is subject to change without notice.

ERICSSON BLUETOOTH STARTER KIT (EBSK)

Information regarding Bluetooth is subject to change without notice.
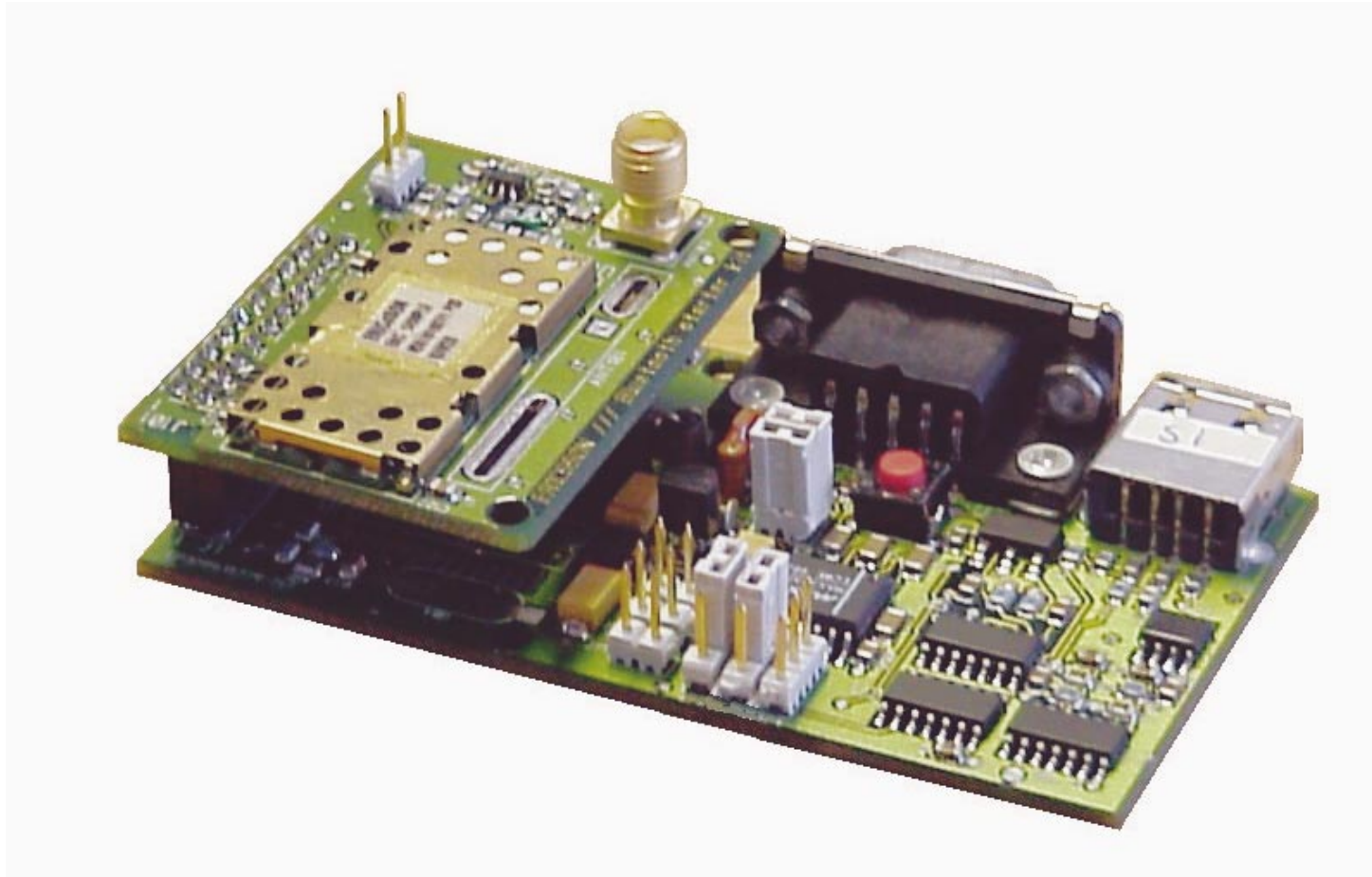
THE ERICSSON BLUETOOTH OPERATING SYSTEM INDEPENDENT SOURCE CODE STACK (EBOSISCS)

Information regarding Bluetooth is subject to change without notice.
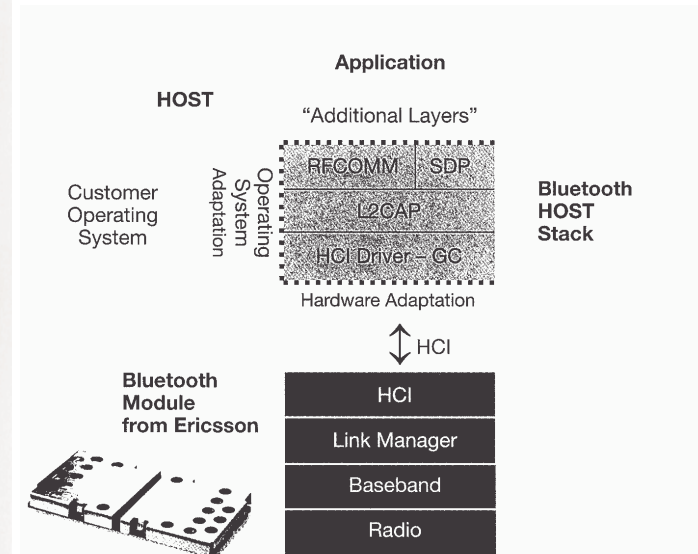
BLUETOOTH HOST STACK

- **Software component containing some of the higher layers of the Bluetooth protocol stack such as HCI driver, L2CAP, SDP, RFCOMM.**

- **Independent of the O/S and the hardware. Virtual Operating System (VOS) concept makes the stack directly adaptable for a wide range of RTOS like OSE, pSOS+, VxWorks, Windows, UNIX etc.**

- **Stack communicates with the Ericsson Bluetooth Module via the HCI interface which is standardised by the B/T SIG.**

Information regarding Bluetooth is subject to change without notice.

WHAT IS A PROFILE?

A Bluetooth Profile

Defines one and only one way of implementing a specific functionality or use case.

Sometimes defines which application to use.

Defines which provided and adapted protocols to use.

Puts requirements on each protocol.

Defines which options in each protocol that are mandatory for the profile.

Defines parameter ranges for each protocol.

VCARD

OBEX

RFCOMM   SDP   TCS Binary

L2CAP   HCI Driver

                    HCI

Link Manager   HCI

Base Band

Radio

Applications

Provided Protocols

Adapted Protocols

Basic Protocols

Protocol Layer

Mandatory Functions

Optional Functions   ✔

Parameters
Buffer Size: **128 B**

Information regarding Bluetooth is subject to change without notice.

Bluetooth

SUPPORTED PROFILES AND ROLES

Fax Profile

DT Terminal	Gateway

Dial-up Networking Profile

DT Terminal	Gateway

Headset Profile

Audio GW	Headset

Synchronization Profile

IrMC Client	IrMC Server

File Transfer Profile

Client	Server

Object Push Profile

Push Client	Push Server

Intercom Profile

Terminal

Cordless Telephony Profile

Terminal	Gateway

LAN Access Profile

DT Terminal	LAN Acc P

Based on
AT Commands

Generic Object Exchange Profile

Client	Server

Generic Access Profile (MANDATORY)

A-Party	B-Party

Serial Port Profile

Device A	Device B

Service Discovery Application Profile

Local Dev	Remote Dev

Bluetooth Profiles

RFCOMM
L2CAP

SDP
L2CAP

TCS Binary
L2CAP

Bluetooth Protocols

Bluetooth

Information regarding Bluetooth is subject to change without notice.
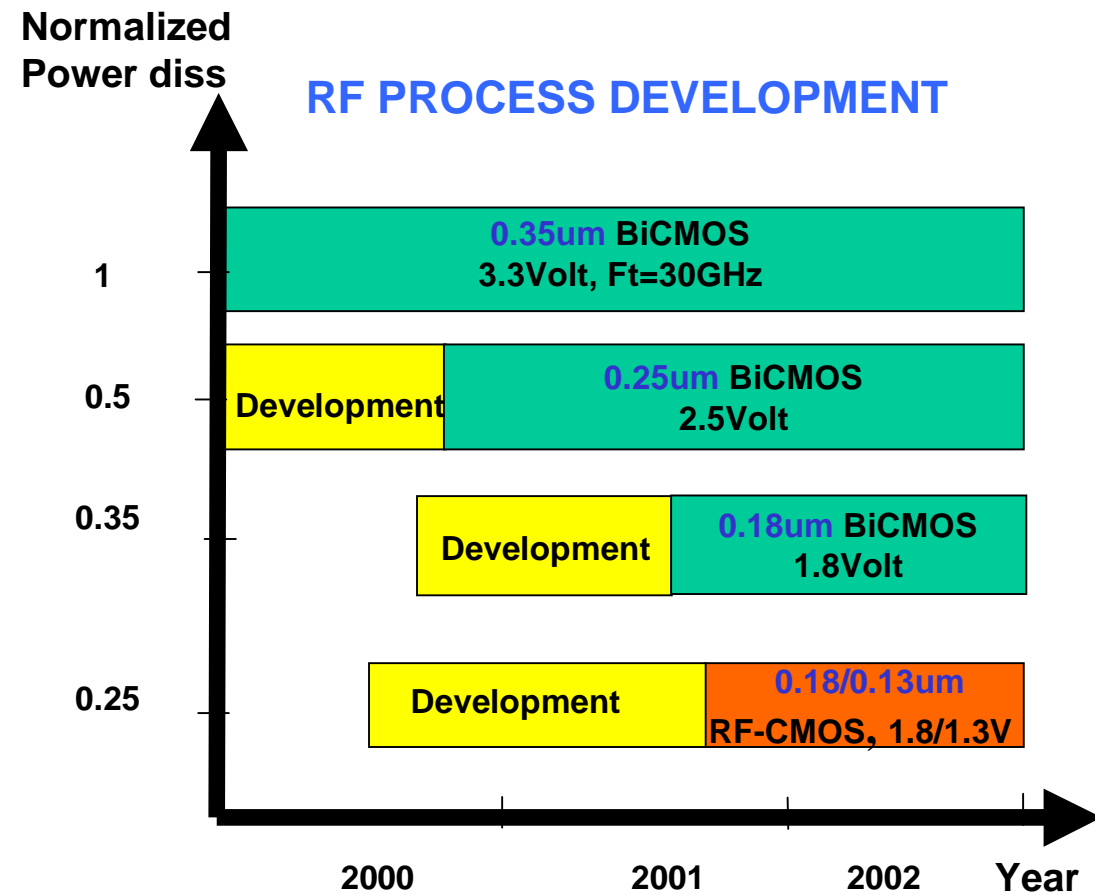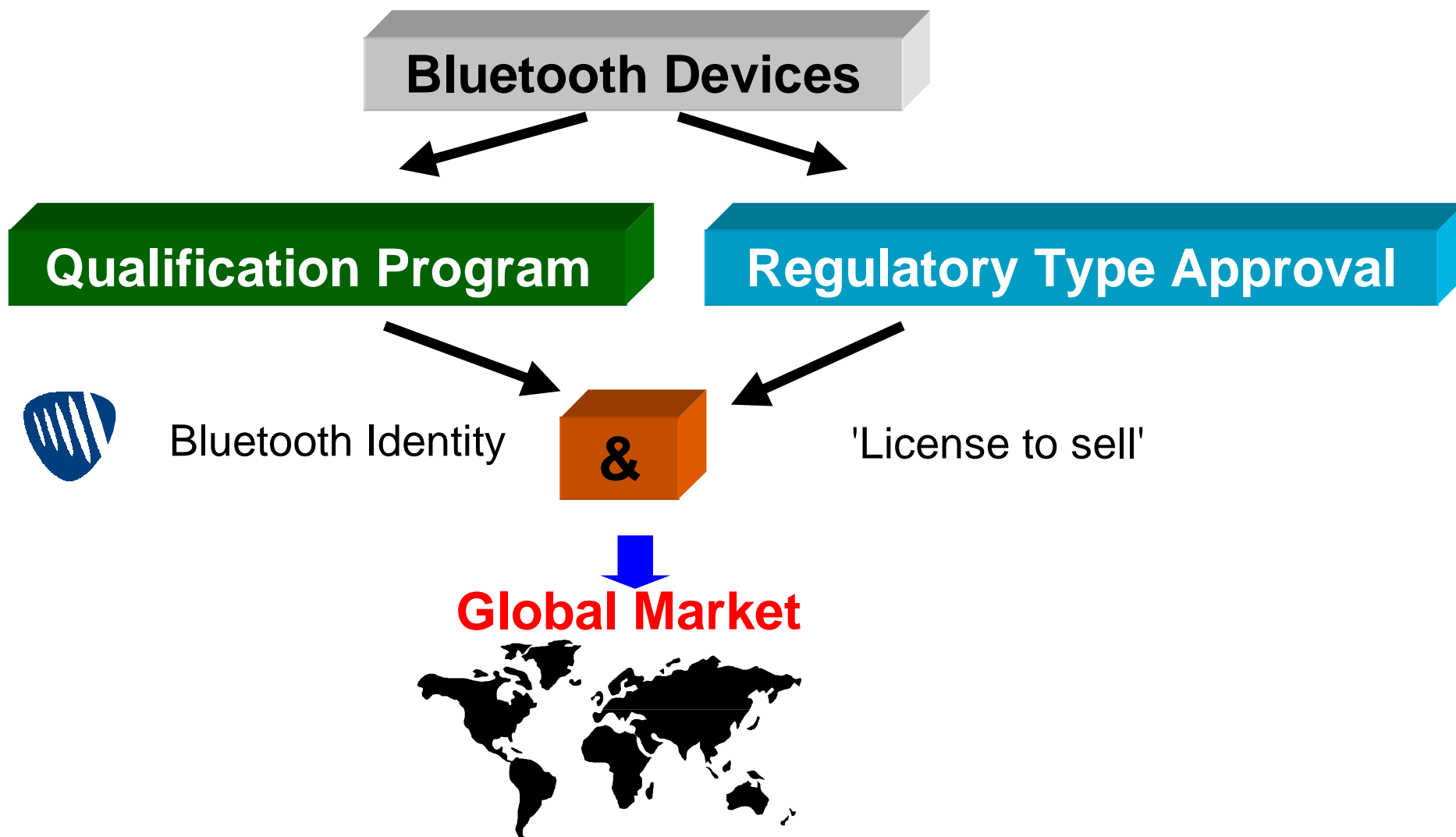
ERICSSON BLUETOOTH IC PROCESS STRATEGY

- **World class RF processes developed inhouse**
- **RF production capacity secured by:**
  - **inhouse production**
  - **foundry**
- **Cost effective standard CMOS processes at foundries**

Normalized Power diss

RF PROCESS DEVELOPMENT

1	0.35um BiCMOS 3.3Volt, Ft=30GHz
0.5	Development | 0.25um BiCMOS 2.5Volt
0.35	Development | 0.18um BiCMOS 1.8Volt
0.25	Development | 0.18/0.13um RF-CMOS, 1.8/1.3V

2000   2001   2002   Year

Information regarding Bluetooth is subject to change without notice.

QUALIFICATION AND TYPE APPROVAL

Bluetooth Devices

Qualification Program

Regulatory Type Approval

Bluetooth Identity   **&**   'License to sell'

Global Market

Bluetooth

Information regarding Bluetooth is subject to change without notice.

THE BLUETOOTH BRAND

Bluetooth ™

● **Purpose**

– **Clear communication of Bluetooth consumer benefits and brand values**

● **The Bluetooth brand values**

– **The Bluetooth brand is the promise of freedom, security, simplicity, versatility, and reliability in connecting devices**

● **The Bluetooth brand book**

– **Brand book provides guidelines to support licensees in the use of the Bluetooth name and mark**

Information regarding Bluetooth is subject to change without notice.
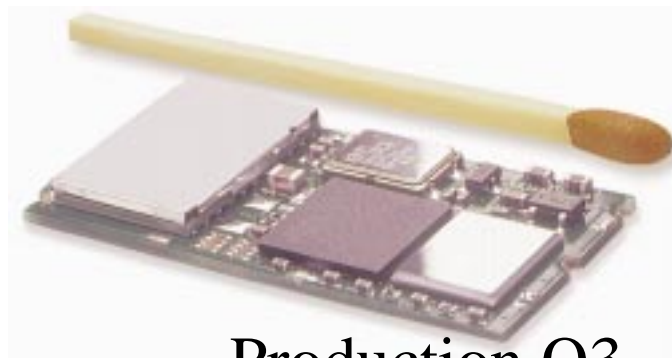
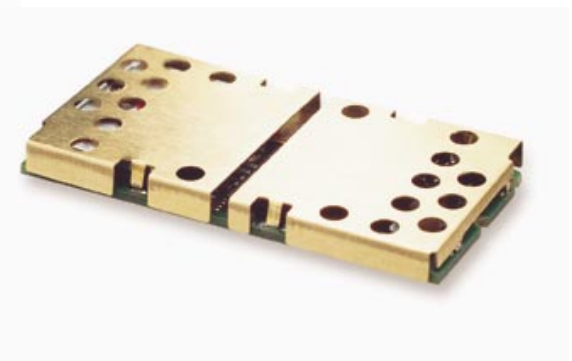# ERICSSON'S BLUETOOTH PRODUCTS SUMMARY

Q2 2000

Q2 2000

Available now

Available now
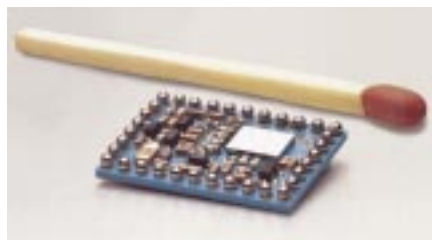
Production Q2 2000, prototypes available now

Production Q3 2000, prototypes available now

Information regarding Bluetooth is subject to change without notice.

<u>INTERESTING WEB SITES</u>

- **Http://www.bluetooth.com (Page run by Bluetooth SIG, includes specs and qualification info and news etc)**

- **http://www.ericsson.se/microe/bluetooth.html (Ericsson page containing datasheets of products and further information etc)**

Bluetooth

Information regarding Bluetooth is subject to change without notice.