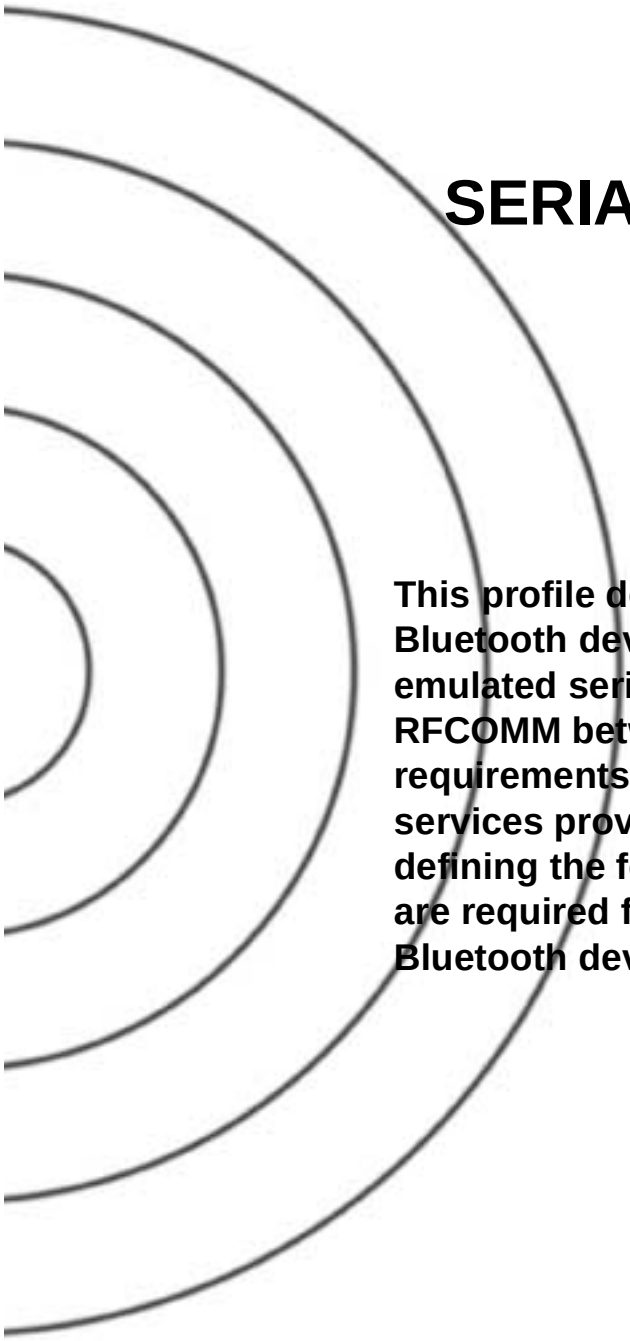
Part K:5

SERIAL PORT PROFILE



This profile defines the requirements for Bluetooth devices necessary for setting up emulated serial cable connections using RFCOMM between two peer devices. The requirements are expressed in terms of services provided to applications, and by defining the features and procedures that are required for interoperability between Bluetooth devices.

CONTENTS

FOREWORD

Interoperability between devices from different manufacturers is provided for a specific service and use case, if the devices conform to a Bluetooth SIG-defined profile specification. A profile defines a selection of messages and procedures (generally termed *capabilities*) from the Bluetooth SIG specifications, and gives an unambiguous description of the air interface for specified service(s) and use case(s).

All defined features are process-mandatory. This means that if a feature is used, it is used in a specified manner. Whether the provision of a feature is mandatory or optional is stated separately for both sides of the Bluetooth air interface.

1 INTRODUCTION

1.1 SCOPE

The Serial Port Profile defines the protocols and procedures that shall be used by devices using Bluetooth for RS232 (or similar) serial cable emulation.

The scenario covered by this profile deals with legacy applications using Bluetooth as a cable replacement, through a virtual serial port abstraction (which in itself is operating system-dependent).

1.2 BLUETOOTH PROFILE STRUCTURE

In Figure 1.1, the Bluetooth profile structure and the dependencies of the profiles are depicted. A profile is dependent upon another profile if it re-uses parts of that profile, by implicitly or explicitly referencing it. Dependency is illustrated in the figure: a profile has dependencies on the profile(s) in which it is contained – directly and indirectly.

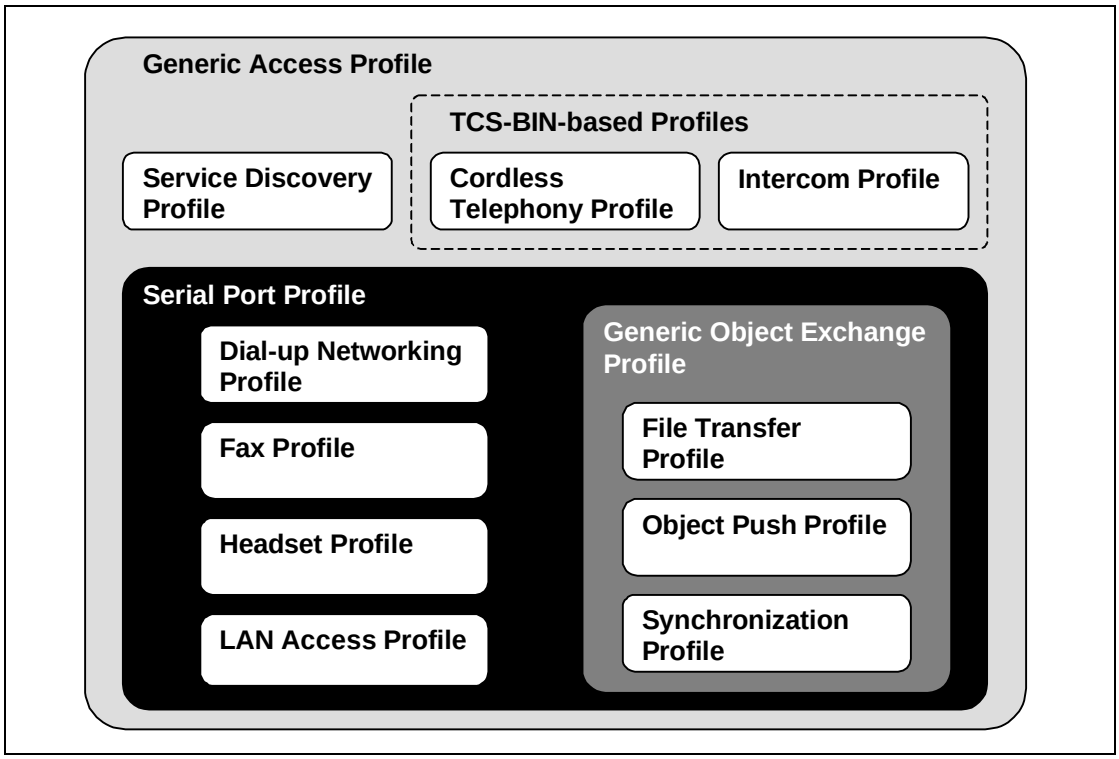


Figure 1.1: Bluetooth Profiles

1.3 SYMBOLS AND CONVENTIONS

This profile uses the symbols and conventions specified in Section 1.2 of the Generic Access Profile [9].

2 PROFILE OVERVIEW

2.1 PROFILE STACK

The figure below shows the protocols and entities used in this profile.

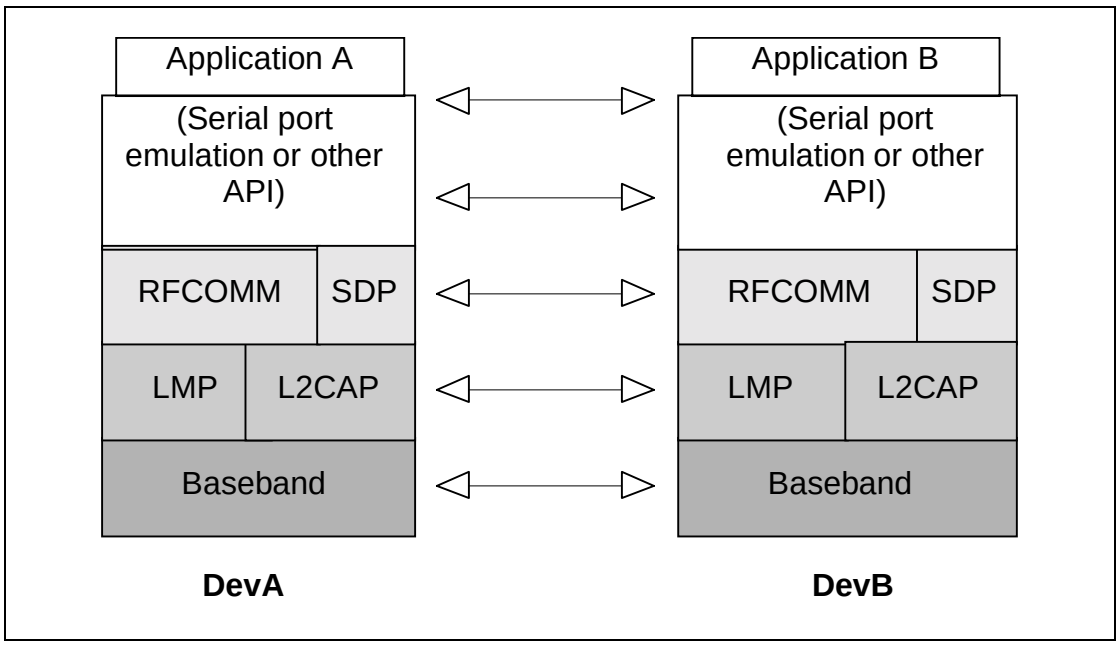


Figure 2.1: Protocol model

The Baseband [1], LMP [2] and L2CAP [3] are the OSI layer 1 and 2 Bluetooth protocols. RFCOMM [4] is the Bluetooth adaptation of GSM TS 07.10 [5], providing a transport protocol for serial port emulation. SDP is the Bluetooth Service Discovery Protocol [6].

The port emulation layer shown in Figure 2.1 is the entity emulating the serial port, or providing an API to applications.

The applications on both sides are typically legacy applications, able and wanting to communicate over a serial cable (which in this case is emulated). But legacy applications cannot know about Bluetooth procedures for setting up emulated serial cables, which is why they need help from some sort of Bluetooth-aware helper application on both sides. (These issues are not explicitly addressed in this profile; the major concern here is for Bluetooth interoperability.)

2.2 CONFIGURATIONS AND ROLES

The figure below shows one possible configuration of devices for this profile:

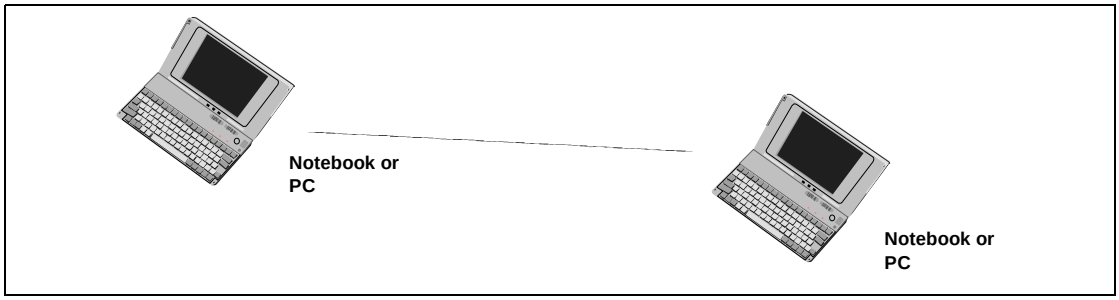


Figure 2.2: Serial Port profile, example with two notebooks.

The following roles are defined for this profile:

Device A (DevA) – This is the device that takes initiative to form a connection to another device (DevA is the *Initiator* according to Section 2.2 in GAP [9]).

Device B (DevB) – This is the device that waits for another device to take initiative to connect. (DevB is the *Acceptor* according to Section 2.2 in GAP [9]).

Note that the order of connection (from DevA to DevB) does not necessarily have to have anything to do with the order in which the legacy applications are started on each side respectively.

Informational note: For purposes of mapping the Serial Port profile to the conventional serial port architecture, both DevA and DevB can be either a Data Circuit Endpoint (DCE) or a Data Terminal Endpoint (DTE). (The RFCOMM protocol is designed to be independent of DTE-DCE or DTE-DTE relationships.)

2.3 USER REQUIREMENTS AND SCENARIOS

The scenario covered by this profile is the following:

- Setting up virtual serial ports (or equivalent) on two devices (e.g. PCs) and connecting these with Bluetooth, to emulate a serial cable between the two devices. Any legacy application may be run on either device, using the virtual serial port as if there were a real serial cable connecting the two devices (with RS232 control signalling).

This profile requires support for one-slot packets only. This means that this profile ensures that data rates up to 128 kbps can be used. Support for higher rates is optional.

Only one connection at a time is dealt with in this profile. Consequently, only point-to-point configurations are considered. However, this should not be construed as imposing any limitation on concurrence; multiple executions of this profile should be able to run concurrently in the same device. This also includes taking on the two different roles (as DevA and DevB) concurrently.

2.4 PROFILE FUNDAMENTALS

For the execution of this profile, use of security features such as authorization, authentication and encryption is optional. Support for authentication and encryption is mandatory, such that the device can take part in the corresponding procedures if requested from a peer device. If use of security features is desired, the two devices are paired during the connection establishment phase (if not earlier), see GAP, Section 7.

Bonding is not explicitly used in this profile, and thus, support for bonding is optional.

Link establishment is initiated by DevA. Service discovery procedures have to be performed to set up an emulated serial cable connection.

There are no fixed master slave roles.

RFCOMM is used to transport the user data, modem control signals and configuration commands.

2.5 CONFORMANCE

When conformance to this profile is claimed, all capabilities indicated mandatory for this profile shall be supported in the specified manner (process-mandatory). This also applies for all optional and conditional capabilities for which support is indicated. All mandatory capabilities and optional and conditional capabilities, for which support is indicated, are subject to verification as part of the Bluetooth certification program.

3 APPLICATION LAYER

This section describes the feature requirements on units complying with the Serial Port profile.

This profile is built upon the Generic Access Profile [9].

- When reading [9], the A-party (the connection initiator) is equivalent to DevA and the B-party is equivalent to the DevB.
- All the mandatory requirements defined in [9] are mandatory for this profile.
- Unless otherwise stated below, all the optional requirements defined in [9] are optional for this profile.

3.1 PROCEDURE OVERVIEW

Table 3.1 shows the required procedures:

	Procedure	Support in DevA	Support in DevB
1.	Establish link and set up virtual serial connection.	M	X
2.	Accept link and establish virtual serial connection.	X	M
3.	Register Service record for application in local SDP database.	X	M

Table 3.1: Application layer procedures

3.1.1 Establish link and set up virtual serial connection

This procedure refers to performing the steps necessary to establish a connection to an emulated serial port (or equivalent) in a remote device. The steps in this procedure are:

1. Submit a query using SDP to find out the RFCOMM Server channel number of the desired application in the remote device.
   This might include a browsing capability to let the user select among available ports (or services) in the peer device. Or, if it is known exactly which service to contact, it is sufficient look up the necessary parameters using the Service Class ID associated with the desired service.
2. Optionally, require authentication of the remote device to be performed. Also optionally, require encryption to be turned on.
3. Request a new L2CAP channel to the remote RFCOMM entity.
4. Initiate an RFCOMM session on the L2CAP channel.

5. Start a new data link connection on the RFCOMM session, using the aforementioned server channel number.

After step 5, the virtual serial cable connection is ready to be used for communication between applications on both sides.

Note: If there already exists an RFCOMM session between the devices when setting up a new data link connection, the new connection must be established on the existing RFCOMM session. (This is equivalent to skipping over steps 3 and 4 above.)

Note: The order between steps 1 and 2 is not critical (may be the other way round).

3.1.2 Accept link and establish virtual serial connection

This procedure refers to taking part in the following steps:

1. If requested by the remote device, take part in authentication procedure and, upon further request, turn on encryption.
2. Accept a new channel establishment indication from L2CAP.
3. Accept an RFCOMM session establishment on that channel.
4. Accept a new data link connection on the RFCOMM session. This may trigger a local request to authenticate the remote device and turn on encryption, if the user has required that for the emulated serial port being connected to (and authentication/encryption procedures have not already been carried out).

Note: steps 1 and 4 may be experienced as isolated events when there already exists an RFCOMM session to the remote device.

3.1.3 Register Service record in local SDP database

This procedure refers to registration of a service record for an emulated serial port (or equivalent) in the SDP database. This implies the existence of a Service Database, and the ability to respond to SDP queries.

All services/applications reachable through RFCOMM need to provide an SDP service record that includes the parameters necessary to reach the corresponding service/application, see Section 6.1. In order to support legacy applications running on virtual serial ports, the service registration must be done by some helper-application, which is aiding the user in setting up the port.

3.2 POWER MODE AND LINK LOSS HANDLING

Since the power requirements may be quite different for units active in the Serial Port profile, it is not required to use any of the power-saving modes. However, requests to use a low-power mode shall, if possible, not be denied.

If sniff, park, or hold mode is used, neither RFCOMM DLCs nor the L2CAP channel are released.

If a unit detects the loss of link, RFCOMM shall be considered having been shut down. The disconnect DLC and shutdown RFCOMM procedures referenced in Section 4 shall not be performed. Before communication on higher layers can be resumed, the Initialize RFCOMM session procedure has to be performed.

4 RFCOMM INTEROPERABILITY REQUIREMENTS

This section describes the requirements on RFCOMM in units complying with the Serial Port profile.

	Procedure	Ability to initiate		Ability to respond	
		DevA	DevB	DevA	DevB
1.	Initialize RFCOMM session	M1	X1	X1	M1
2.	Shutdown RFCOMM session	M	M	M	M
3.	Establish DLC	M	X1	X1	M
4.	Disconnect DLC	M	M	M	M
5.	RS232 control signals	C1	C1	M	M
6.	Transfer information	M	M	N/A1	N/A1
7.	Test command	X	X	M	M
8.	Aggregate flow control	C1	C1	M	M
9.	Remote Line Status indication	O	O	M	M
10.	DLC parameter negotiation	O	O	M	M
11.	Remote port negotiation	O	O	M	M

Table 4.1: RFCOMM capabilities

M1: The ability to have more than one RFCOMM session operational concurrently is optional in the RFCOMM protocol. Although support of concurrence is encouraged where it makes sense, this profile does not mandate support of concurrent RFCOMM sessions in either DevA or DevB.

X1: Within the execution of the roles defined in this profile, these abilities will not be used.

N/A1: Information transfer is unacknowledged in the RFCOMM protocol.

C1: Which flow control mechanism to use (per-DLC, aggregate, or both) is an implementation issue. But, if an implementation cannot guarantee that there will always be buffers available for data received, the ability to send either per-DLC flow control or aggregate flow control is mandatory.

Some of the procedures are further commented in subsections below.

4.1 RS232 CONTROL SIGNALS

According to TS 07.10 [5], section 5.4.6.3.7, all devices are required to send information on all changes in RS232 control signals with the Modem Status Command.

However, since RFCOMM can be used with an adaptation layer implementing any kind of API (not only virtual serial ports), it is optional to use all RS232 control signals except flow control (the RTR signal in TS 07.10 [5]). This signal can be mapped on RTS/CTS or XON/XOFF or other API mechanisms, which is an implementation issue.

Informative note: To provide interoperability between devices actually using all RS232 control signals, and devices not using them, the former type of implementation must set the states of the appropriate signals in APIs/connectors to suitable default values depending on RFCOMM DLC state. The implementation must not rely on receiving any RS232 control information from peer devices. The dependency on RFCOMM DLC state may mean that DSR/DTR as well as DCD are set to high level when an RFCOMM DLC has been established, and that the same signals are set to low level if the corresponding DLC is closed for any reason.

4.2 REMOTE LINE STATUS INDICATION

It is required to inform the other device of any changes in RS232 line status with the Remote Line Status indication command, see [5], section 5.4.6.3.10, if the local device relays information from a physical serial port (or equivalent) where overrun-, parity- or framing-errors may occur.

4.3 REMOTE PORT NEGOTIATION

DevA may inform DevB of RS232 port settings with the Remote Port Negotiation Command, directly before DLC establishment. See [5], section 5.4.6.3.9. There is a requirement to do so if the API to the RFCOMM adaptation layer exposes those settings (e.g. baud rate, parity).

DevB is allowed to send the Remote Port Negotiation command.

Informative note: the information conveyed in the remote port negotiation procedure is expected to be useful only in type II devices (with physical serial port) according to section 1.2 in RFCOMM [4], or if data pacing is done at an emulated serial port interface for any reason. RFCOMM as such will not artificially limit the throughput based on baud rate settings, see RFCOMM [4], chapter 2.

5 L2CAP INTEROPERABILITY REQUIREMENTS

The following text together with the associated sub-clauses defines the mandatory requirements with regard to this profile.

	Procedure	Support in DevA/DevB
1.	Channel types	
	Connection-oriented channel	M
	Connectionless channel	X1
2.	Signalling	
	Connection Establishment	M
	Configuration	M
	Connection Termination	M
	Echo	M
	Command Rejection	M
3.	Configuration Parameter Options	
	Maximum Transmission Unit	M
	Flush Timeout	M
	Quality of Service	O

Table 5.1: L2CAP procedures

X1: Connectionless channel is not used within the execution of this profile, but concurrent use by other profiles/applications is not excluded.

5.1 CHANNEL TYPES

In this profile, only connection-oriented channels shall be used. This implies that broadcasts will not be used in this profile.

In the PSM field of the Connection Request packet, the value for RFCOMM defined in the Assigned Numbers document [8], section 3.2 must be used.

5.2 SIGNALLING

Only DevA may issue an L2CAP Connection Request within the execution of this profile. Other than that, the Serial Port Profile does not impose any additional restrictions or requirements on L2CAP signalling.

5.3 CONFIGURATION OPTIONS

This section describes the usage of configuration options in the Serial Port Profile.

5.3.1 Maximum Transmission unit

This profile does not impose any restrictions on MTU sizes over the restrictions stated in L2CAP [3], section 6.1.

5.3.2 Flush Timeout

Serial Port data is carried over a reliable L2CAP channel. The flush timeout value shall be set to its default value 0xffff.

5.3.3 Quality of Service

Negotiation of Quality of Service is optional in this profile.

Recommendation: Implementations should try to keep an upper limit of 500 milliseconds on the latency incurred when going back from a low power mode to active mode.

6 SDP INTEROPERABILITY REQUIREMENTS

6.1 SDP SERVICE RECORDS FOR SERIAL PORT PROFILE

There are no SDP Service Records related to the Serial Port Profile in DevA.

The following table is a description of the Serial Port related entries in the SDP database of DevB. It is allowed to add further attributes to this service record.

Item	Definition	Type/Size	Value	AttributeID
ServiceClassIDList			Note1	0x0001
ServiceClass0	SerialPort / Note3	UUID	Note1	
ProtocolDescriptorList				0x0004
Protocol0	L2CAP	UUID	L2CAP /Note1	
Protocol1	RFCOMM	UUID	RFCOMM /Note1	
ProtocolSpecificParameter0	Server Channel	Uint8	N = server channel #	
ServiceName	Displayable text name	DataElement/ String	“COM5” / Note4	Note2

Table 6.1: SDP Service Record

Notes:

1. Defined in the Assigned Numbers document [8].
2. For national language support for all “displayable” text string attributes, an offset has to be added to the LanguageBaseAttributeIDList value for the selected language (see the SDP Specification [6], section 5.1.14 for details).
3. The ‘SerialPort’ class of service is the most generic type of service. Addition of other, more specific services classes are not excluded by this profile.
4. The ServiceName attribute value suggested here is merely an example; a helper application setting up a serial port may give the port a more descriptive name.

6.2 SDP PROCEDURES

To retrieve the service records in support of this profile, the SDP client entity in DevA connects and interacts with the SDP server entity in DevB via the SDP and L2CAP procedures presented in sections 5 and 6 of SDAP [7]. In accordance to SDAP, DevA plays the role of the LocDev, while DevB plays the role of the RemDev.

7 LINK MANAGER (LM) INTEROPERABILITY REQUIREMENTS

7.1 CAPABILITY OVERVIEW

In addition to the requirements on supported procedures stated in the Link Manager specification itself (see Section 3 in the Link Manager Protocol), this profile also requires support for Encryption both in DevA and DevB.

7.2 ERROR BEHAVIOR

If a unit tries to use a mandatory feature, and the other unit replies that it is not supported, the initiating unit shall send an LMP_detach with detach reason "unsupported LMP feature."

A unit shall always be able to handle the rejection of the request for an optional feature.

7.3 LINK POLICY

There are no fixed master-slave roles for the execution of this profile.

This profile does not state any requirements on which low-power modes to use, or when to use them. That is up to the Link Manager of each device to decide and request as seen appropriate, within the limitations of the latency requirement stated in Section 5.3.3.

8 LINK CONTROL (LC) INTEROPERABILITY REQUIREMENTS

8.1 CAPABILITY OVERVIEW

The following table lists all capabilities on the LC level, and the extra requirements added to the ones in the baseband specification by this profile.

	Capabilities	Support in DevA	Support in DevB
1.	Inquiry		X1
2.	Inquiry scan	X1	
3.	Paging		X1
4.	Page scan		
A	Type R0	X1	
B	Type R1	X1	
C	Type R2	X1	
5.	Packet types		
A	ID packet		
B	NULL packet		
C	POLL packet		
D	FHS packet		
E	DM1 packet		
F	DH1 packet		
G	DM3 packet		
H	DH3 packet		
I	DM5 packet		
J	DH5 packet		
K	AUX packet	X1	X1
L	HV1 packet		
M	HV2 packet		
N	HV3 packet		
O	DV packet		
6.	Inter-piconet capabilities		

Table 8.1: Baseband/LC capabilities

	Capabilities	Support in DevA	Support in DevB
7.	Voice codec		
A	A-law		
B	μ-law		
C	CVSD		

Table 8.1: Baseband/LC capabilities

X1: These capabilities are not used within the execution of this profile, but concurrent use by other profiles/applications is not excluded.

8.2 INQUIRY

When inquiry is invoked in DevA, it shall use the General Inquiry procedure, see GAP [9], Section 6.1.

Only DevA may inquire within the execution of this profile.

8.3 INQUIRY SCAN

For inquiry scan, (at least) the GIAC shall be used, according to one of the discoverable modes defines in GAP [9], Section 4.1.2. and Section 4.1.3. That is, it is allowed to only use the Limited discoverable mode, if appropriate for the application(s) residing in DevB.

In the DevB INQUIRY RESPONSE messages, the Class of Device field will not contain any hint as to whether DevB is engaged in the execution of the Serial Port Profile or not. (This is due to the fact the generalized Serial Port service for legacy applications delivered by this profile does not fit within any of the major Service Class bits in the Class Of Device field definition.)

8.4 PAGING

Only DevA may page within the execution of this profile. The paging step will be skipped in DevA when execution of this profile begins when there already is a baseband connection between DevA and DevB. (In such a case the connection may have been set up as a result of previous paging by DevB.)

8.5 ERROR BEHAVIOR

Since most features on the LC level have to be activated by LMP procedures, errors will mostly be caught at that layer. However, there are some LC procedures that are independent of the LMP layer, e.g. inquiry or paging. Misuse of such features is difficult or sometimes impossible to detect. There is no mechanism defined to detect or prevent such improper use.

9 REFERENCES

[1] Bluetooth Special Interest Group, Bluetooth baseband specification

[2] Bluetooth Special Interest Group, Link Manager Protocol

[3] Bluetooth Special Interest Group, L2CAP Specification

[4] Bluetooth Special Interest Group, RFCOMM with TS 07.10

[5] ETSI, TS 101 369 (GSM 07.10) version 6.3.0

[6] Bluetooth Special Interest Group, Service Discovery Protocol (SDP)

[7] Bluetooth Special Interest Group, Service Discovery Application Profile

[8] Bluetooth Special Interest Group, Bluetooth Assigned Numbers
http://www.bluetooth.org/assigned-numbers.htm

[9] Bluetooth Special Interest Group, Generic Access Profile

10 LIST OF FIGURES

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