Title

Paging Concept Paper (Version 5)

Source

AT&T Wireless

Abstract

This contribution proposes a concept paper for paging. It uses the following three-part template adopted in GAHW-010241 [16]: identify requirements, recommend concept, and identify impact on specifications.

The requirements section uses the model proposed by Alan Cooper in *The Inmates are Running the Asylum – Why High-Tech Products Drive Us Crazy and How to Restore the Sanity*.

Questions and comments appear in magenta within angled brackets, *e.g.*, <comment>.

Proposals appear in blue, *e.g.*, proposal.

This contribution is available in *Acrobat* and *Word* formats. The *Acrobat* format is smaller and has fewer display artifacts.

Recommendation

Review, amend, and adopt.

History

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Contents

1. Requirements ... 3
1.1 Persona ... 3
1.2 User-based requirements ... 3
1.3 System-based requirements ... 3
1.4 User-based scenarios ... 4
1.5 System-based scenarios ... 4

2. Concept ... 5
2.1 Incoming circuit voice call – assign dedicated channel ... 5
2.2 Incoming circuit voice call – assign shared channel ... 13
2.3 Incoming packet voice call – assign dedicated channel ... 13
2.4 Incoming packet voice call – assign shared channel ... 18
2.5 Incoming packet-data transaction – assign shared channel ... 18

3. Impact on specifications ... 27
3.1 Changes to 23.060 (GPRS stage 2) ... 27
3.2 Changes to 24.008 (CN protocols) ... 27
3.3 Changes to 25.413 (UTRAN RANAP) ... 27
3.4 Changes to 44.018 (GERAN RRC) ... 28
3.5 Changes to 44.060 (GERAN RLC/MAC) ... 29
3.6 Changes to 45.002 (L1 Multiplexing) ... 29

4. References ... 30

A. Network-operation modes ... 31
A.1 GPRS ... 31
A.2 UMTS ... 31
A.3 GERAN ... 31

B. Paging equations ... 32
B.1 CCCH ... 32
B.1.1 Paging blocks per CCCH multiframe (N_m) ... 32
B.1.2 Paging blocks per CCCH (N_c, M_c) ... 32
B.1.3 Paging blocks per cell (N_t, M_t) ... 33
B.1.4 Monitored CCCH ... 33
B.1.5 Monitored paging block on CCCH ... 34
B.1.6 Paging multiframe ... 35
B.1.7 Paging-block index (i) ... 35
B.2 PCCCH ... 36
B.2.1 Paging blocks per PCCCH multiframe (N_{pm}) ... 36
B.2.2 Paging blocks per PCCCH (M_{pc}) ... 36
B.2.3 Paging blocks per cell (N_{pt}) ... 36
B.2.4 Monitored PCCCH ... 36
B.2.5 Monitored paging block on PCCCH ... 37
B.2.6 Paging multiframe ... 37
B.2.7 Paging-block index (i) ... 37
B.3 UTRAN ... 38
B.4 DRX values for UTRAN ... 38

C. States ... 39
C.1 MM states ... 39
C.2 PMM states ... 39
C.3 RCC modes ... 39
C.4 RRC states ... 40

1. Requirements

This document presents paging-related requirements. Based on these requirements, it develops concepts, and from the concepts, assesses the impact on new and existing standards. To focus requirements, it proposes persona, as suggested by Alan Cooper in *The Inmates are Running the Asylum* [1].

1.1 Persona

Lloyd sells specialty automotive parts for Merit, a multinational supplier. His customers include autobody shops, garages, trucking companies, fleet operators, and auto-parts retailers.

Lloyd's key objective is customer service: customers should be able to phone him at any time and get through to Lloyd or his voice mail. From 08:00 to 19:00, seven days a week, Lloyd returns calls within 2 hours.

Lloyd uses two wireless devices:

- A small handset exclusively used for voice.
  The handset is on 24 hours a day, 7 days a week. It is Lloyd's key communication device. This handset complies with release-99 specifications for voice terminals. It does not support GPRS.

- A laptop computer for checking stock and processing orders.
  This laptop contains a GPRS PC card that allows wireless data access to Merit's servers. The computer is only on when Lloyd is entering new orders or checking status of outstanding orders. Lloyd seldom uses e-mail: he prefers to talk to his customers by phone or meet with them in person.

In the future, Lloyd may want a single device that allows him to perform everything he does now. This document assumes the future is now.

1.2 User-based requirements

To increase battery life, paging shall support discontinuous reception.

Incoming voice calls shall be processed whether or not a data session is active.

Incoming data transfers shall be processed whether or not a voice call is active.

1.3 System-based requirements

Since the PCCCH has more signalling capacity than CCCH, any mobile station that is in *MAC-Idle* state and that supports *Iu mode* shall behave as follows:

- If a PCCCH is available, camp on PCCCH.

- Otherwise, camp on CCCH. *Iu-mode* shall not be available.

So the core network and GERAN can establish a signalling link with a mobile station, two types of paging shall be supported: GERAN-initiated and CN-initiated. The mobile station shall be able to determine which network (GERAN or CN) initiated the page.

For efficiency, a single *packet paging request* should be able to contain pages for *A/Gb-mode* and *Iu-mode* mobile stations.

For flexibility, a mobile station may respond to a page via a dedicated control channel or via a TBF. Note, however, that if a mobile station responds to a circuit page using a TBF, and it reselects to a new cell, it may loose the incoming call.

Iu-mode paging shall comply with the concepts in this document.

A/Gb-mode paging shall comply with the concepts in 43.064 [7].

1.4 User-based scenarios

The following scenarios will be used to develop the paging concepts in § 2:

- Lloyd receives a voice call. While engaged in the voice call, Lloyd receives an order confirmation.
- Lloyd receives an order confirmation. While engaged in the order confirmation, Lloyd receives a voice call.

1.5 System-based scenarios

GERAN shall initiate a page for the following purposes:

- Locate a mobile station to its serving cell.
- Activate radio bearers.

The CN shall initiate a page for the following purposes:

- Locate a mobile station to its serving BSS.
- Activate radio access bearers.

2. Concept

This section uses concepts from X.200 [11], X.210 [12], Z.100 [13], and Z.120 [14]. These concepts are not intended to unnecessarily constrain implementations.

Sequences in this section derive from the requirements and scenarios of § 1. Figures contain the sequence diagrams. A table following each figure describes message events in the sequence, including the values of directly relevant information elements.

<Until 44.118 stabilizes, information elements specified in the tables may be a strange mix of UTRAN and GERAN.>

Within each sequence diagram, the following conventions apply:

- Green arrows indicate unciphered messages.
- Red arrows indicate ciphered messages.

  <Ciphered messages need to be confirmed when the concept paper on ciphering and integrity protection is ready.>

- Dashed arrows indicate optional messages.
- Heavy vertical or diagonal lines indicate a stimulus-response relationship between messages.
- Magenta hexagons indicate PMM and MM states.
- Cyan hexagons indicate RRC states and modes.
- Yellow hexagons indicate MAC states.
- Circles indicate an initiating event.

Unless stated otherwise, the following conditions apply for each sequence:

- The CN and GERAN operate in *GERAN Network Operation Mode II:* SGSN and MSC are not connected via a *Gs* interface; circuit pages arrive over the *Iu-cs* interface. See § A for a description of network-operation modes for GPRS, UMTS, and GERAN.
- The PCCCH supports discontinuous reception according to the formulas described in § B.2.
- MM, PMM, and RRC have the states described in § C.

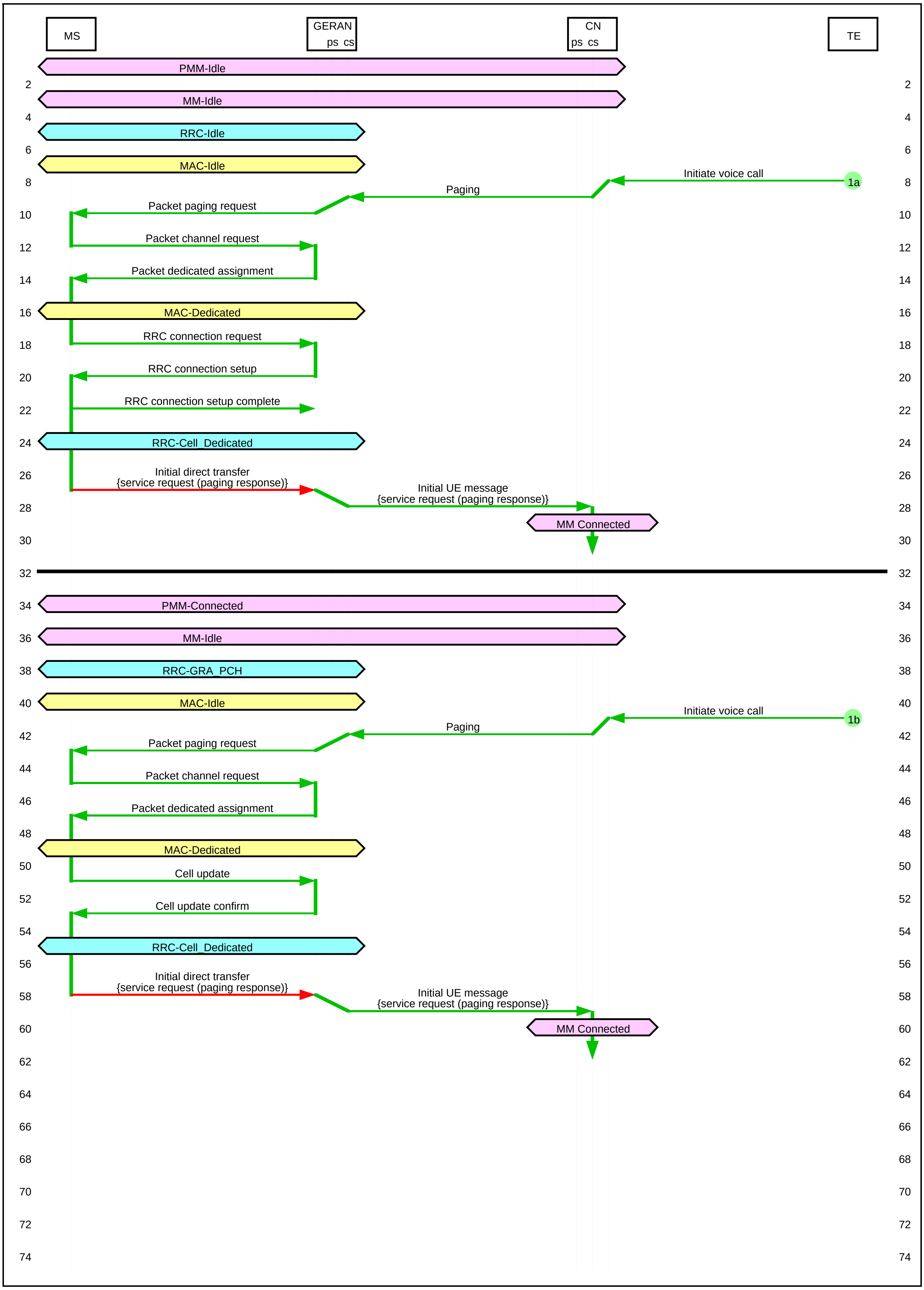
2.1 Incoming circuit voice call – assign dedicated channel

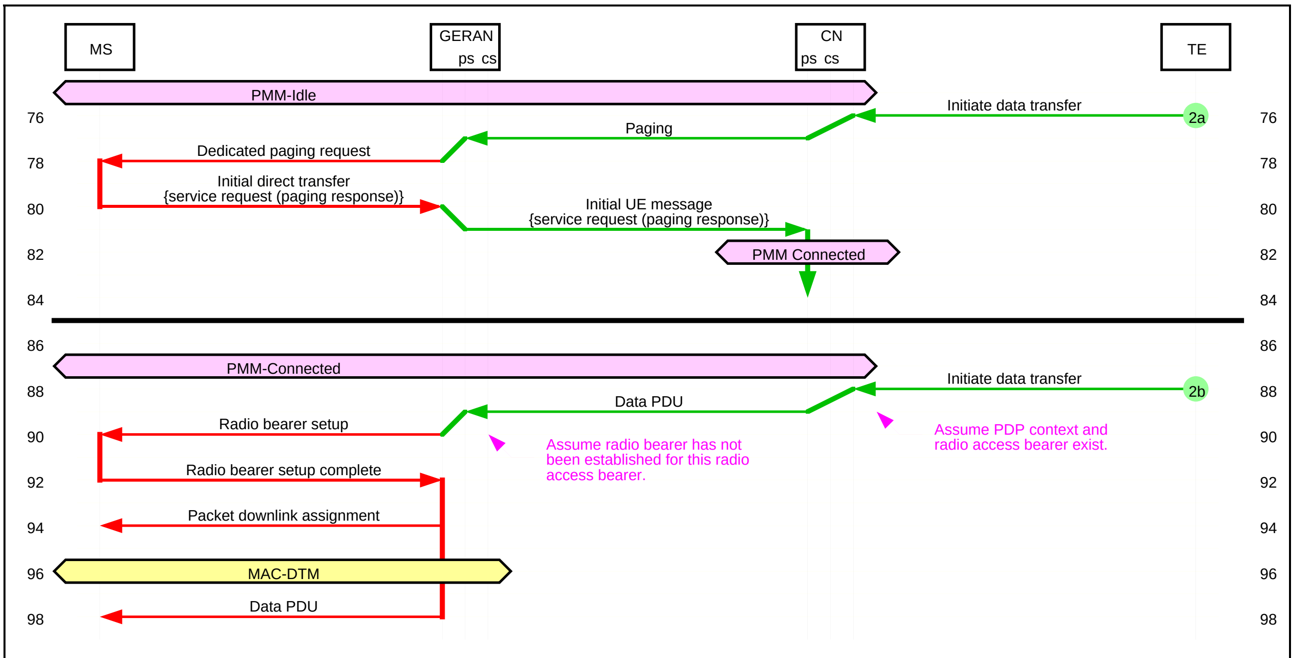
This sequence corresponds to the following user-based scenario:

1. Lloyd receives a voice call. The core network routes the call via the *Iu-cs* interface. The GERAN RRC assigns a dedicated transport channel for the mobile station to respond to the voice-call page.
   a. No RRC connection exists.
   b. An RRC connection and a PMM connection exist as a result of a previous packet-data transaction.
2. While engaged in the voice call, Lloyd receives an order confirmation. The core network routes the data via the *Iu-ps* interface. The GERAN RRC uses the existing dedicated transport channel to initiate the data transaction.
   a. No PMM connection exists.
   b. A PMM connection exists as a result of a previous packet-data transaction.

Figure 1 shows the paging-related portions of this scenario.

Figure 1: Incoming circuit voice call





Line	Description	Direction Protocol Channel
1	**Sequence 1a** Lloyd receives a voice call when no RRC connection exists. The following initial conditions apply: • PMM is in *PMM-Idle state*. • MM is in *MM-Idle state*. • RRC is in *RRC-Idle mode*. • MAC is in *MAC-Idle state*; the mobile station monitors a PCCCH.	
8	Initiate voice call Lloyd's customer calls. The customer's terminal equipment initiates the voice call.	CN←TE
9	Paging *{CN domain indicator, permanent NAS UE identity, temporary UE identity, paging area ID, paging cause, non-searching indication, DRX cycle-length coefficient}* The CN non-access stratum requests paging in each GERAN BSS (Base-Station Subsystem) in which the mobile station could be located, *i.e.*, each BSS within the mobile station's location area. • *CN domain indicator* indicates *circuit domain*. • *Permanent NAS UE* identity is the IMSI. • *Temporary UE identity*, if included, is the TMSI. • *Paging area ID*, if included, is the LAI. If the message contains no *paging area ID*, the GERAN BSS will page in all cells under its control. • *Paging cause*, if included, indicates *terminating conversational call.* • *Non-searching indication*, if included, indicates one of two values: • If a signalling connection exists for the other domain, send paging via the connection instead of via the paging channel. Otherwise, send paging via the paging channel. This is the default setting. Unless otherwise stated, this document assumes the default. • Always send paging via the paging channel. • *DRX cycle-length coefficient*, if included, is used to calculate when the mobile station may be paged. This parameter should only apply to UTRAN mobile stations. As proposed at the November GERAN2 meeting, discontinuous reception could work as follows: • The BSS broadcasts a default *Split_PG_Cycle* on PBCCH. The MS uses this value in *RRC-Idle mode*. During RRC connection setup, the MS provides to the BSS its specific *GERAN split paging cycle*. The MS and GERAN use this specific value in *RRC-Connected mode*. • The MS would continue to send its *Split_PG_Cycle* during GPRS attach and routing-area update, but the core network and BSS wouldn't use this value. Also, the *DRX cycle coefficient* in RANAP would be ignored. Therefore, RANAP need not be changed.	GERAN←CN RANAP *Iu-cs*

10	Packet paging request *{page mode, persistence level, NLN, page info (TBF or dedicated, mobile identity, channel needed)}* Since the GERAN RRC is in *Idle* mode for this IMSI, it does not know where the mobile station is. It therefore has MAC send a CN-initiated *packet paging request* on all paging channels the mobile station could monitor. Upon receipt of the *packet paging request*, the MS MAC informs its non-access stratum that the core network has paged it. The MS NAS responds to the page. • *TBF or dedicated* indicates establishment of a dedicated connection. • *Mobile identity* is the mobile station's IMSI, or if available, TMSI. • *Channel needed* indicates SDCCH. It could also indicate TCH. The following should be added to the *packet paging request:* • An implicit indication of which network element initiated the page: CN or GERAN. The presence of *paging cause* indicates a CN-initiated page; the absence of *paging cause* indicates a GERAN-initiated page. This requires that GERAN indicate a *paging cause* of *cause unknown* if the CN does not provide a *paging cause* in the RANAP *paging* message. • An indication of which core network initiated the page: circuit-domain or packet-domain. If paging with IMSI, include this element. If paging with P-TMSI or TMSI, omit the element since the identity implicitly indicates the network initiating the page. • *Paging cause* from the RANAP *paging* message.	MS←GERAN MAC PCCCH (PPCH)
12	Packet channel request *{establishment cause, random reference}* Under control of the MS RRC, the MS MAC requests a channel to respond to the page. • *Establishment cause* should indicate a high-priority access for which GERAN should assign a dedicated channel.	MS→GERAN MAC PCCCH (PRACH)
14	Packet dedicated assignment *{<parameters>}* *{page mode, channel description, packet request reference, timing advance, mobile allocation, starting time, IA rest octets (frequency parameters before time)}* The GERAN RRC has MAC assign a dedicated channel. This is a new message. • <specify parameter settings.> • *Packet request reference* comprises the contents of the *packet channel request* and the frame number in which the GERAN MAC received the *packet channel request*. It is used to address the mobile station.	MS←GERAN MAC PCCCH (PAGCH)
16	MAC-Dedicated The MS and GERAN MACs enter *MAC-Dedicated state.*	
18	RRC connection request *{initial UE identity, establishment cause}* Since the MS RRC is in *RCC-Idle* mode, it needs to establish an RRC connection with its GERAN peer. It therefore sends an *RRC connection request.* • *Initial UE identity* indicates IMSI, or if available, TMSI. • *Establishment cause* indicates terminating *conversational call*.	MS→GERAN RRC RB0 (SDCCH)
20	RRC connection setup *{initial UE identity, RRC transaction identifier, new U-RNTI, RRC state indicator, UTRAN DRX cycle-length coefficient, signalling RB information setup list}* The GERAN RRC provides the information needed to support the RRC connection. • *Initial UE identity* indicates IMSI, or if available, TMSI. • *RRC transaction identifier* identifies the transaction. Subsequent messages in the transaction use this identifier. • *New U-RNTI* (in GERAN, G-RNTI) provides the new GERAN *Radio Network Temporary Identifier*. The identifier applies for the duration of the RRC connection. • *RRC state indicator* specifies that the mobile station enter *RRC-Cell_Dedicated* state. • *UTRAN DRX cycle-length coefficient* is used to calculate when the mobile station may be paged while connected to this UTRAN. GERAN will use *GERAN split paging cycle*. See line 9. • *Signalling RB information setup list* configures the four signaling radio bearers.	MS←GERAN RRC RB0 (SDCCH)

22	RRC connection setup complete *{RRC transaction identifier, START list, UE radio access capability}* The MS RRC confirms setup of the RRC connection. • *RRC transaction identifier* is the value sent in the *RRC connection setup* message. • *START list* identifies the CN domain (circuit) and initializes the 20 most-significant bits of the hyperframe numbers. <Is this the first point where ciphering and integrity protection can operate?> • *UE radio-access capability* indicates the mobile station's capabilities with respect to the *Um* interface, *e.g.*, PDCP capability, RLC capability, RF capability.	MS→GERAN RRC RB2 (SDCCH)
24	RRC-Cell_Dedicated The MS and GERAN RRCs enter *RRC-Cell_Dedicated* state. The following radio bearers now exist: RB1 (unacknowledged access-stratum signalling), RB2 (acknowledged access-stratum signalling), RB3 (acknowledged high-priority non-access-stratum signalling), and RB4 (acknowledged low-priority non-access-stratum signalling).	
27	Initial direct transfer *{CN domain identity, intra-domain NAS node selector, NAS message}* The MS RRC initiates a signaling connection to the circuit CN and forwards the MS NAS paging response. • *CN domain identity* indicates *circuit domain*. • *Intra-domain NAS node selector* indicates the NAS node to which the MS wants to establish a connection. • *NAS message* contains the *service request* message indicating *paging response.*	MS→GERAN RRC RB3 (SDCCH)
28	Initial UE message *{CN domain indicator, LAI, SAI, NAS-PDU, Iu signalling-connection identifier, Global RNC-ID}* GERAN forwards the page response to the CN. • *CN domain indicator* indicates *circuit domain*. • *LAI* indicates the location area in which the RRC connection exists. • *SAI* indicates the service area where the mobile station is consuming resources. • *Iu signalling-connection identifier* is assigned by GERAN and stored by the CN for the duration of the *Iu* connection. • *Global RNC-ID* uniquely identifies the GERAN BSS.	GERAN→CN RANAP *Iu-cs*
29	MM-Connected The core network enters *MM-Connected state*.	
34	**Sequence 1b** Lloyd receives a voice call when an RRC connection and a PMM connection exist as a result of a previous packet-data transaction. The following initial conditions apply: • PMM is in *PMM-Connected state*. • MM is in *MM-Idle state*. • RRC is in *RRC-GRA_PCH state*. • MAC is in *MAC-Idle state*; the mobile station monitors a PCCCH.	
41	Initiate voice call Same as line 8.	CN←TE
42	Paging *{CN domain indicator, permanent NAS UE identity, temporary UE identity, paging area ID, paging cause, non-searching indication, DRX cycle-length coefficient}* Same as line 9.	GERAN←CN RANAP *Iu-cs*

43	Packet paging request *{page mode, persistence level, NLN, page info (TBF or dedicated, mobile identity, channel needed)}* Since the GERAN RRC is in *RRC-GRA_PCH* state for this IMSI, it knows where the mobile station is within a GRA. It therefore has MAC send a GERAN-initiated *packet paging request* on all paging channels in the GRA. • *TBF or dedicated* indicates establishment of a dedicated connection. • *Mobile identity* is the mobile station's G-RNTI. • *Channel needed* indicates SDCCH. It could also indicate TCH. In addition to line 10, the following should be added to the *packet paging request:* • G-RNTI as a *mobile identity*.	MS←GERAN MAC PCCCH (PPCH)
45	Packet channel request *{establishment cause, random reference}* Same as line 12.	MS→GERAN MAC PCCCH (PRACH)
47	Packet dedicated assignment *{<parameters>}* Same as line 14.	MS←GERAN MAC PCCCH (PAGCH)
49	MAC-Dedicated The MS and GERAN MACs enter *MAC-Dedicated state.*	
51	Cell update *{U-RNTI, START list, AM_RLC error indication (RB2 or RB3), AM_RLC error indication (RB4 and upwards), cell-update cause, RB-timer indicator}* The MS RRC updates its cell-location information in the GERAN RRC by sending a *cell update*. The GERAN RRC now knows the mobile station's location to the cell level instead of the GRA level. • *U-RNTI* (in GERAN, G-RNTI) identifies the mobile station. • *START list* identifies the CN domain (circuit) and initializes the 20 most-significant bits of the hyperframe numbers. • *AM_RLC error indication (RB2 or RB3)* indicates *no error*. • *AM_RLC error indication (RB4 and upwards)* indicates *no error*. • *Cell-update cause* indicates *paging response*. • *RB-timer indicator* indicates if T314 or T315 have expired. These timers relate to radio-link failure.	MS→GERAN RRC RB1 (SDCCH)
53	Cell update confirm *{RRC transaction identifier, activation time, RRC state indicator, UTRAN DRX cycle length coefficient, RLC re-establish indicator (RB2 and RB3), RLC re-establish indicator (RB4 and upwards),* <channel and radio-resource configuration information elements (reams of information elements of dubious usefulness)>*}* The GERAN RRC confirms that it has updated the cell-location information. • *RRC transaction identifier* identifies the transaction. Subsequent messages in the transaction use this identifier. • *Activation time* indicates when changes signaled by the message take effect. If not included, the default is *now*. • *RRC state indicator* specifies that the mobile station enter *RRC-Cell_Dedicated* state. • *UTRAN DRX cycle-length coefficient* is used to calculate when the mobile station may be paged while connected to this UTRAN. GERAN may use this capability, *i.e.*, DRX cycle length may change when the mobile station moves from *RRC Idle* mode to *RRC connected* mode. • *RLC re-establish indicator (RB2 and RB3)* indicates that RB2 and RB3 should be re-established. • *RLC re-establish indicator (RB4 and upwards)* indicates that RB4 and higher radio bearers should be re-established.	MS←GERAN RRC RB1 (SDCCH)
55	RRC-Cell_Dedicated The MS and GERAN RRCs enter *RRC-Cell_Dedicated* state.	

58	Initial direct transfer *{CN domain identity, intra-domain NAS node selector, NAS message* Same as line 27.	MS→GERAN RRC RB3 (SDCCH)
59	Initial UE message *{CN domain indicator, LAI, SAI, NAS-PDU, Iu signalling-connection identifier, Global RNC-ID}* Same as line 28.	GERAN→CN RANAP *Iu-cs*
60	MM-Connected The core network enters *MM-Connected state*.	
75	**Sequence 2a** While engaged in the voice call from sequence 1a, Lloyd receives an order confirmation. The following conditions apply: • PMM is in *PMM-Idle state*. • MM is in *MM-Connected state*. • RRC is in *RRC-Cell_Dedicated state*. • MAC is in *MAC-Dedicated state*.	
76	Initiate data transfer Lloyd's server sends a customer-order confirmation.	CN←TE
77	Paging *{CN domain indicator, permanent NAS UE identity, temporary UE identity, paging area ID, paging cause, non-searching indication, DRX cycle-length coefficient}* Same as line 9 except for the following: • *CN domain indicator* indicates *packet domain.* • *Temporary UE identity*, if included, is the P-TMSI. • *Paging area ID*, if included, is the RAI. If the message contains no *paging area ID*, GERAN will page in all cells under its control. • *Paging cause*, if included, indicates *terminating background call*.	GERAN←CN RANAP *Iu-ps*
78	Dedicated paging request *{RRC transaction identifier, paging cause, CN domain identity, paging record type identifier}* Since the GERAN RRC is in *RRC-Cell_Dedicated* state for this IMSI, it knows where the mobile station is and it has radio bearers established to that mobile station. It therefore sends a CN-initiated *dedicated paging request* on RB2. Upon receipt of the *dedicated paging request*, the MS RRC informs its non-access stratum that the core network has paged it. The MS NAS responds to the page. • *RRC transaction identifier* identifies the transaction. Subsequent messages in the transaction use this identifier. • *Paging cause* indicates *terminating background call.* • *CN domain identity* indicates *packet domain.* • *Paging record type identifier* indicates *P-TMSI.* The following should be added to 44.018: • A *dedicated paging request* based on 25.331 *paging type 2.*	MS←GERAN RRC RB2 (FACCH)
80	Initial direct transfer *{CN domain identity, intra-domain NAS node selector, NAS message}* The MS RRC initiates a signaling connection to the packet CN and forwards the MS NAS paging response. • *CN domain identity* indicates *packet domain*. • *Intra-domain NAS node selector* indicates the NAS node to which the MS wants to establish a connection. • *NAS message* contains the *service request* message indicating *paging response.*	MS→GERAN RRC RB3 (FACCH)
81	Initial UE message *{CN domain indicator, LAI, RAC, SAI, NAS-PDU, Iu signalling-connection identifier, Global RNC-ID}* Same as line 28 except for the following: • *CN domain indicator* indicates *packet domain*. • *RAC* indicates the routing area in which the RRC connection exists.	GERAN→CN RANAP *Iu-ps*

82	PMM-Connected The core network enters *PMM-Connected state*.	
87	**Sequence 2b** While engaged in the voice call from sequence 1b, Lloyd receives an order confirmation. The following conditions apply: • PMM is in *PMM-Connected state*. • MM is in *MM-Connected state*. • RRC is in *RRC-Cell_Dedicated state*. • MAC is in *MAC-Dedicated state*.	
88	Initiate data transfer Same as line 76.	CN←TE
89	Data PDU Since the CN still has an *Iu* connection for this mobile station, it sends the data PDU to GERAN via the RAB established for this purpose (RABx).	GERAN←CN GTP RABx (*Iu-ps*)
90	Radio bearer setup *{RRC transaction identifier, starting time, RRC state identifier, GERAN split paging cycle, RB parameters, physical-layer parameters, PDTCH parameters}* Since the GERAN RRC is in *RRC-Cell-Dedicated state* for this IMSI, it does not have to page the mobile station. Since the sequence assumes no radio bearer exists for the radio access bearer, RRC configures a radio bearer (RBx) to carry the data. • <specify parameter settings.>	MS←GERAN RRC RB2 (FACCH)
92	Radio bearer setup complete *{RRC transaction identifier, RB parameters}* The MS RRC confirms configuration of the radio bearer. • <specify parameter settings.>	MS→GERAN RRC RB2 (FACCH)
94	Packet downlink assignment *{page mode, persistence level, G-RNTI, MAC mode, RLC mode, control ack, timeslot allocation, packet timing advance, P0, BTS pwr-control mode, PR mode, frequency parameters, downlink TFI assignment, power-control parameters, TBF starting time, measurement mapping}* Under control of the GERAN RRC, the GERAN MAC allocates a downlink TBF. • *G-RNTI* is the identity assigned at RRC connection. It is used to address the mobile station. • *MAC mode* indicates any of the four allocation modes: dynamic, extended dynamic, fixed, fixed half-duplex. • *RLC mode* indicates *acknowledged*. • *Downlink TFI assignment* assigns a TFI for the downlink TBF. The following should be added to the *packet downlink assignment*: • G-RNTI as a method of mobile-station identification. • Radio-bearer identity.	MS←GERAN MAC PBCCH
96	MAC-DTM The MS and GERAN MACs enter *MAC-DTM state.*	
98	Data PDU GERAN forwards the data to the MS.	MS←GERAN PDCP RBx (PDTCH)

1

2.2 Incoming circuit voice call – assign shared channel

This sequence corresponds to the following user-based scenario:

1. Lloyd receives a voice call. The core network routes the call via the *Iu-cs* interface. The GERAN RRC assigns a shared transport channel for the mobile station to respond to the voice-call page.

2. While engaged in the voice call, Lloyd receives an order confirmation. The core network routes the data via the *Iu-ps* interface. The GERAN RRC uses the existing dedicated transport channel to initiate the data transaction.

Sequences in this section are deprecated for the following reasons:

- If the mobile station reselects a new cell, the incoming voice call will be lost. <Network control of cell reselection may mitigate this problem.>

Since the sequences are deprecated, they have been abandoned. GP-011538 contains the abandoned sequences.

2.3 Incoming packet voice call – assign dedicated channel

This sequence corresponds to the following user-based scenario:

1. Lloyd receives a voice call. The core network routes the call via the *Iu-ps* interface. The GERAN RRC assigns a dedicated transport channel for the mobile station to respond to the voice-call page.

    a. No RRC connection exists.

    b. An RRC connection and a PMM connection exist as a result of a previous packet-data transaction.

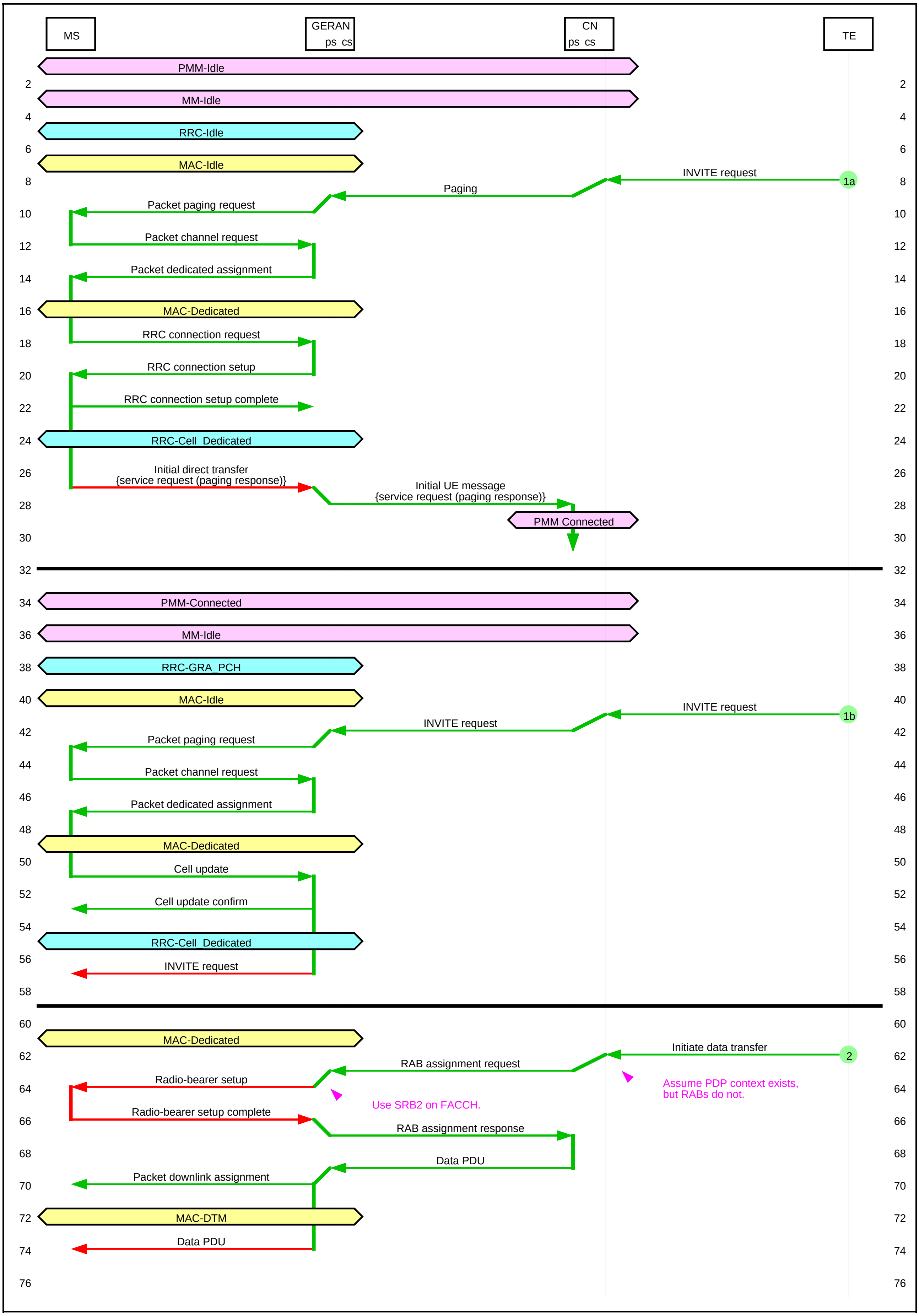
2. While engaged in the voice call, Lloyd receives an order confirmation. The core network routes the data via the *Iu-ps* interface. The GERAN RRC uses the existing dedicated transport channel to initiate the data transaction.

    a. No PMM connection exists.

    b. A PMM connection exists as a result of a previous packet-data transaction.

Figure 2 shows the paging-related portions of this scenario.

Figure 2: Incoming packet voice call



Line	Description	Direction Protocol Channel
1	**Sequence 1a** Lloyd receives a voice call when no RRC connection exists. The following initial conditions apply: • PMM is in *PMM-Idle state*. • MM is in *MM-Idle state*. • RRC is in *RRC-Idle mode*. • MAC is in *MAC-Idle state*; the mobile station monitors a PCCCH.	
8	INVITE request Lloyd's customer calls. The TE calling-user agent initiates the voice call by sending an *INVITE request* to Lloyd's SIP URL (Session Initiation Protocol Uniform Resource Locator). Based on the context associated with the URL and the contents of the SIP message, the CN determines that it has to page the mobile station with a paging cause of *terminating conversational call.* The above has been simplified to protect the sanity of the reader.	CN←TE SIP
9	Paging *{CN domain indicator, permanent NAS UE identity, temporary UE identity, paging area ID, paging cause, non-searching indication, DRX cycle-length coefficient}* Same as figure 1 line 9 with the following exceptions: • The CN requests paging in the mobile station's routing area, not its location area. • *CN domain indicator* indicates *packet domain*. • *Temporary UE identity*, if included, is the P-TMSI. • *Paging area ID,* if included, is the RAI. If the message contains no *paging area ID*, the GERAN BSS will page in all cells under its control.	GERAN←CN RANAP *Iu-ps*
10	Packet paging request *{page mode, persistence level, NLN, page info (TBF or dedicated, mobile identity, channel needed)}* Same as figure 1 line 10 with the following exceptions: • *TBF or dedicated* must indicate *page request for RR connection establishment*, even though P-TMSI may be used. 44.060 § 11.2.10 does not presently allow this. • *Mobile identity* is the mobile station's IMSI, or if available, P-TMSI. The following should be changed in the *packet paging request:* • Support paging with P-TSMI for RR connection establishment.	MS←GERAN MAC PCCCH (PPCH)
12	Packet channel request *{establishment cause, random reference}* Same as figure 1 line 12.	MS→GERAN MAC PCCCH (PRACH)
14	Packet dedicated assignment *{<parameters>}* Same as figure 1 line 14.	MS←GERAN MAC PCCCH (PAGCH)
16	MAC-Dedicated The MS and GERAN MACs enter *MAC-Dedicated state.*	
18	RRC connection request *{initial UE identity, establishment cause}* Same as figure 1 line 18 with the following exceptions: • *Initial UE identity* indicates IMSI, or if available, P-TMSI.	MS→GERAN RRC RB0 (SDCCH)
20	RRC connection setup *{initial UE identity, RRC transaction identifier, new U-RNTI, RRC state indicator, UTRAN DRX cycle-length coefficient, signalling RB information setup list}* Same as figure 1 line 20 with the following exceptions: • *Initial UE identity* indicates IMSI, or if available, P-TMSI.	MS←GERAN RRC RB0 (SDCCH)
22	RRC connection setup complete *{RRC transaction identifier, START list, UE radio access capability}* Same as figure 1 line 22.	MS→GERAN RRC RB2 (SDCCH)

24	RRC-Cell_Dedicated The MS and GERAN RRCs enter *RRC-Cell_Dedicated* state. The following radio bearers now exist: RB1 (unacknowledged access-stratum signalling), RB2 (acknowledged access-stratum signalling), RB3 (acknowledged high-priority non-access-stratum signalling), and RB4 (acknowledged low-priority non-access-stratum signalling).	
27	Initial direct transfer *{CN domain identity, intra-domain NAS node selector, NAS message}* Same as figure 1 line 27 with the following exceptions: • *CN domain identity* indicates *packet domain.*	MS→GERAN RRC RB3 (SDCCH)
28	Initial UE message *{CN domain indicator, LAI, RAC, SAI, NAS-PDU, Iu signalling-connection identifier, Global RNC-ID}* Same as figure 1 line 28 with the following exceptions: • *CN domain indicator* indicates *packet domain*. • *RAC* indicates the routing area in which the RRC connection exists.	GERAN→CN RANAP *Iu-ps*
29	PMM-Connected The core network enters *PMM-Connected state*.	
34	**Sequence 1b** Lloyd receives a voice call when an RRC connection and a PMM connection exist as a result of a previous packet-data transaction. The following initial conditions apply: • PMM is in *PMM-Connected state*. • MM is in *MM-Idle state*. • RRC is in *RRC-GRA_PCH state*. • MAC is in *MAC-Idle state*; the mobile station monitors a PCCCH.	
41	INVITE request Same as line 8.	CN←TE SIP
42	INVITE request Since the CN still has an *Iu* connection for this mobile station, it sends the *INVITE request* to GERAN via the RAB established for this purpose (RABx). The GERAN RRC determines it has no physical-layer resources assigned to the radio bearer that serves RABx.	GERAN←CN GTP RABx (*Iu-ps*)
43	Packet paging request *{page mode, persistence level, NLN, page info (TBF or dedicated, mobile identity, channel needed)}* Same as figure 1 line 43.	MS←GERAN RRC PCCCH (PPCH)
45	Packet channel request *{establishment cause, random reference}* Same as line 12.	MS→GERAN MAC PCCCH (PRACH)
47	Packet dedicated assignment *{<parameters>}* Same as line 14.	MS←GERAN MAC PCCCH (PAGCH)
49	MAC-Dedicated The MS and GERAN MACs enter *MAC-Dedicated state.*	
51	Cell update *{U-RNTI, START list, AM_RLC error indication (RB2 or RB3), AM_RLC error indication (RB4 and upwards), cell-update cause, RB-timer indicator}* Same as figure 1 line 51.	MS→GERAN RRC RB1 (SDCCH)

53	Cell update confirm *{RRC transaction identifier, activation time, RRC state indicator, UTRAN DRX cycle length coefficient, RLC re-establish indicator (RB2 and RB3), RLC re-establish indicator (RB4 and upwards),* <channel and radio-resource configuration information elements (reams of information elements of dubious usefulness)>*}* Same as figure 1 line 53 with the following exceptions: • Include parameters to configure the radio bearer that will carry RABx traffic (RBx) and to assign resources for that radio bearer. If this is not desirable, GERAN can use a *packet dedicated assignment* to assign resources for RBx.	MS←GERAN RRC RB1 (SDCCH)
55	RRC-Cell_Dedicated The MS and GERAN RRCs enter *RRC-Cell_Dedicated state*.	
57	INVITE request GERAN delivers the INVITE request to the mobile station.	MS←GERAN PDCP RBx (PDTCH)
61	**Sequence 2** While engaged in the voice call from sequence 1a or 1b, Lloyd receives an order confirmation. The following conditions apply: • PMM is in *PMM-Connected state*. • MM is in *MM-Idle state*. • RRC is in *RRC-Cell_Dedicated state*. • MAC is in *MAC-Dedicated state*.	
62	Initiate data transfer Same as figure 1 line 76.	CN←TE
63	RAB assignment request *{RABs to be setup or modified}* Since no RAB exists for this PDP context, the CN establishes a new RAB (RABx). • *RABs to be setup or modified* proposes configuration parameters for the new RAB.	GERAN←CN RANAP *Iu-ps*
64	Radio bearer setup *{RRC transaction identifier, starting time, RRC state identifier, GERAN split paging cycle, RB parameters, physical-layer parameters, PDTCH parameters}* Same as figure 1 line 90.	MS←GERAN RRC RB2 (FACCH)
66	Radio bearer setup complete *{RRC transaction identifier, RB parameters}* Same as figure 1 line 92.	MS→GERAN RRC RB2 (FACCH)
67	RAB assignment response *{RABs setup or modified}* GERAN responds that RABx has been setup. • *RABs setup or modified* confirms the configuration parameters used for the new RAB.	GERAN→CN RANAP *Iu-ps*
69	Data PDU The CN sends the data PDU to GERAN via the RAB established for this purpose (RABx).	GERAN←CN GTP RABx (*Iu-ps*)
70	Packet downlink assignment *{page mode, persistence level, G-RNTI, MAC mode, RLC mode, control ack, timeslot allocation, packet timing advance, P0, BTS pwr-control mode, PR mode, frequency parameters, downlink TFI assignment, power-control parameters, TBF starting time, measurement mapping}* Same as figure 1 line 94.	MS←GERAN MAC PBCCH
72	MAC-DTM The MS and GERAN MACs enter *MAC-DTM state.*	
74	Data PDU GERAN forwards the data to the MS.	MS←GERAN PDCP RBx (PDTCH)

1

2.4 Incoming packet voice call – assign shared channel

For further study.

2.5 Incoming packet-data transaction – assign shared channel

This sequence corresponds to the following user-based scenario:

1. Lloyd receives an order confirmation. The core network routes the order confirmation via the *Iu-ps* interface, *i.e.*, the order confirmation is a packet-data transaction. The GERAN RRC assigns a shared transport channel for the mobile station to respond to the page.

    a. No RRC connection exists.

    b. An RRC connection and a PMM connection exist as a result of a previous packet-data transaction.

2. While engaged in the packet-data transaction, Lloyd receives a voice call. The GERAN RRC assigns a dedicated transport channel to process the voice call.

    a. MAC is in *MAC-Shared state* and the call arrives as packet voice.

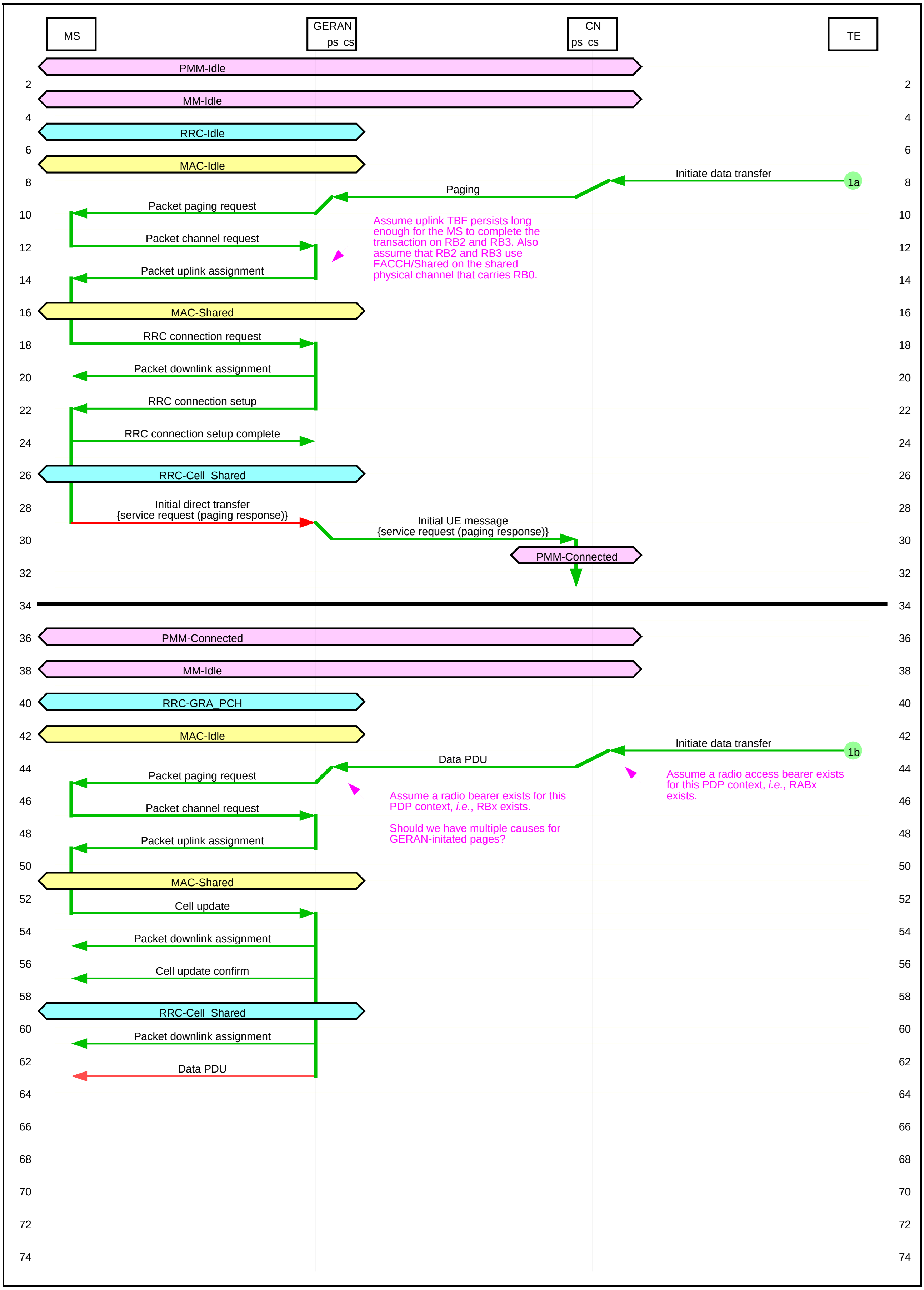
    b. MAC is in *MAC-Idle state* and the call arrives as packet voice.

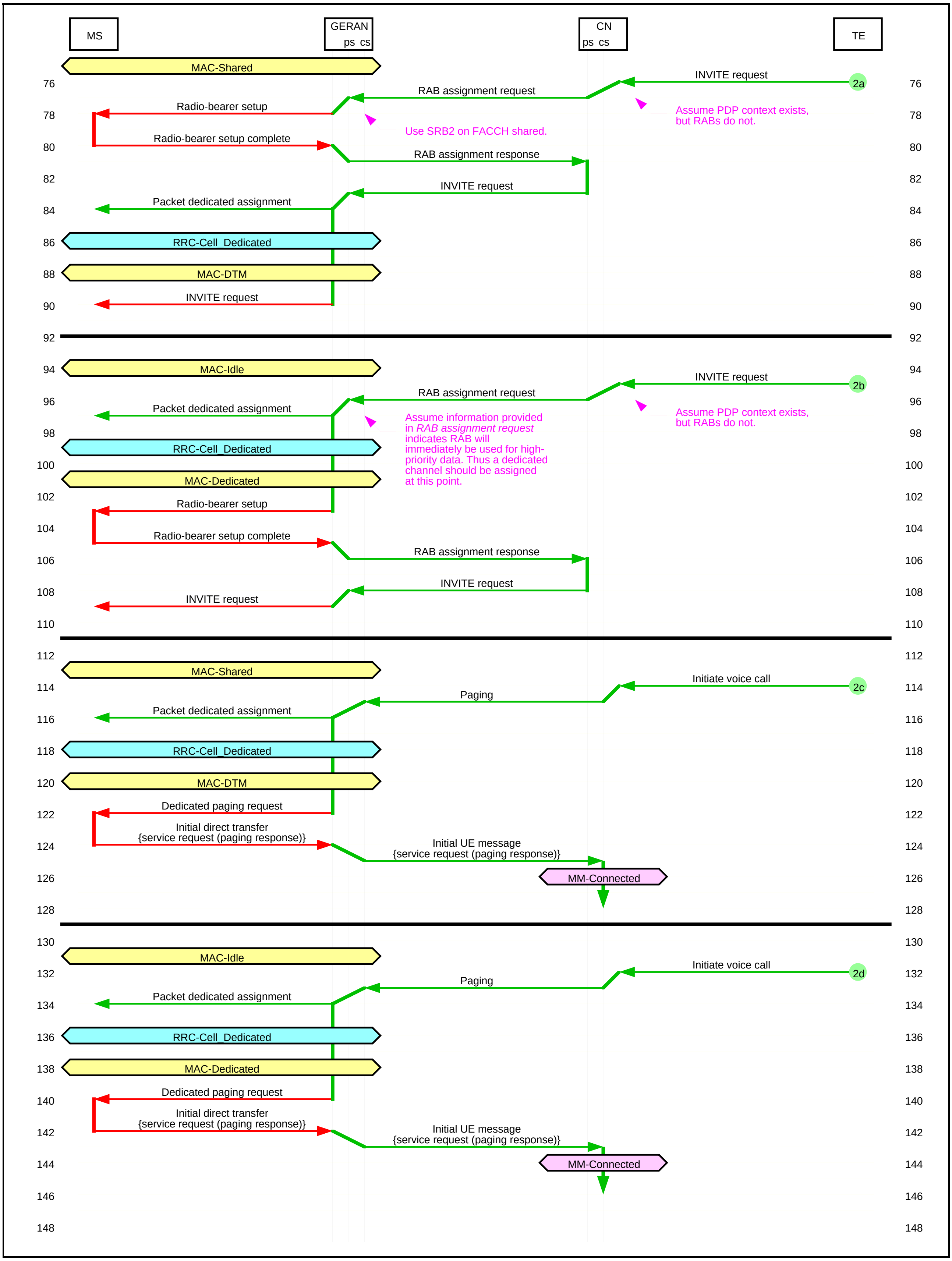
    c. MAC is in *MAC-Shared state* and the call arrives as circuit voice.

    d. MAC is in *MAC-Idle state* and the call arrives as packet voice.

Figure 3 shows the paging-related portions of this scenario.

Figure 3: Incoming packet-data transaction





MS
GERAN
ps cs
CN
ps cs
TE
MAC-Shared
76
INVITE request
2a
RAB assignment request
78
Radio-bearer setup
Assume PDP context exists, but RABs do not.
Use SRB2 on FACCH shared.
80
Radio-bearer setup complete
RAB assignment response
82
INVITE request
84
Packet dedicated assignment
86
RRC-Cell_Dedicated
88
MAC-DTM
90
INVITE request
92
94
MAC-Idle
INVITE request
2b
96
RAB assignment request
Packet dedicated assignment
98
Assume information provided in *RAB assignment request* indicates RAB will immediately be used for high-priority data. Thus a dedicated channel should be assigned at this point.
Assume PDP context exists, but RABs do not.
RRC-Cell_Dedicated
100
MAC-Dedicated
102
Radio-bearer setup
104
Radio-bearer setup complete
106
RAB assignment response
108
INVITE request
INVITE request
110
112
MAC-Shared
114
Initiate voice call
2c
Paging
116
Packet dedicated assignment
118
RRC-Cell_Dedicated
120
MAC-DTM
122
Dedicated paging request
124
Initial direct transfer {service request (paging response)}
Initial UE message {service request (paging response)}
126
MM-Connected
128
130
MAC-Idle
132
Initiate voice call
2d
Paging
134
Packet dedicated assignment
136
RRC-Cell_Dedicated
138
MAC-Dedicated
140
Dedicated paging request
142
Initial direct transfer {service request (paging response)}
Initial UE message {service request (paging response)}
144
MM-Connected
146
148

Line	Description	Direction Protocol Channel
1	**Sequence 1a** Lloyd receives an order confirmation when no RRC connection exists. The following initial conditions apply: • PMM is in *PMM-Idle state*. • MM is in *MM-Idle state*. • RRC is in *RRC-Idle mode*. • MAC is in *MAC-Idle state*; the mobile station monitors a PCCCH.	
8	Initiate data transfer Lloyd's server sends data confirming a customer order.	CN←TE
9	Paging *{CN domain indicator, permanent NAS UE identity, temporary UE identity, paging area ID, paging cause, non-searching indication, DRX cycle-length coefficient}* Same as figure 2 line 9 with the following exceptions: • *Paging cause* indicates *terminating background call.*	GERAN←CN RANAP *Iu-ps*
10	Packet paging request *{page mode, persistence level, NLN, page info (TBF or dedicated, mobile identity, channel needed)}* Same as figure 2 line 10 with the following exceptions: • *TBF or dedicated* indicates TBF establishment. • *Channel needed* is not sent because this information element only applies to dedicated assignments.	MS←GERAN MAC PCCCH (PPCH)
12	Packet channel request *{establishment cause, random reference}* Under control of the MS RRC, the MS MAC requests a channel to respond to the page. • *Establishment cause* should indicate a low-priority access for which GERAN should assign a shared channel.	MS→GERAN MAC PCCCH (PRACH)
14	Packet uplink assignment *{page mode, persistence level, packet-request reference, channel-coding command, TLLI-block channel coding, packet timing advance, frequency parameters, allocation (uplink TFI assignment)}* Under control of the GERAN RRC, the GERAN MAC allocates an uplink TBF. • *Packet-request reference* comprises the contents of the *packet channel request* and the frame number in which the GERAN MAC received the *packet channel request*. It is used to address the mobile station. • *Uplink TFI assignment* assigns a TFI for the uplink TBF.	MS←GERAN MAC PCCCH (PAGCH)
16	MAC-Shared The MS and GERAN MACs enter *MAC-Shared state.*	
18	RRC connection request *{initial UE identity, establishment cause}* Same as figure 2 line 18.	MS→GERAN RRC RB0 (PDTCH)
20	Packet downlink assignment *{page mode, persistence level, global TFI, MAC mode, RLC mode, control ack, timeslot allocation, packet timing advance, P0, BTS pwr-control mode, PR mode, frequency parameters, downlink TFI assignment, power-control parameters, TBF starting time, measurement mapping}* Under control of the GERAN RRC, the GERAN MAC allocates a downlink TBF so that the GERAN RRC can reply. • *Global TFI* is the uplink TFI assigned in line 14. It is used to address the mobile station. • *MAC mode* indicates any of the four allocation modes: dynamic, extended dynamic, fixed, fixed half-duplex. • *RLC mode* indicates *acknowledged*. • *Downlink TFI assignment* assigns a TFI for the downlink TBF.	MS←GERAN MAC PACCH

22	RRC connection setup *{initial UE identity, RRC transaction identifier, new U-RNTI, RRC state indicator, UTRAN DRX cycle-length coefficient, signalling RB information setup list}* Same as figure 2 line 20 with the following exceptions: • *RRC state indicator* specifies that the mobile station enter *RRC Cell-Shared state*.	MS←GERAN RRC RB0 (PDTCH)
24	RRC connection setup complete *{RRC transaction identifier, START list, UE radio access capability}* Same as figure 2 line 22.	MS→GERAN RRC RB2 (FACCH/S)
26	RRC-Cell_Shared The MS and GERAN RRCs enter *RRC-Cell_Shared* state. The following radio bearers now exist: RB1 (unacknowledged access-stratum signalling), RB2 (acknowledged access-stratum signalling), RB3 (acknowledged high-priority non-access-stratum signalling), and RB4 (acknowledged low-priority non-access-stratum signalling).	
29	Initial direct transfer *{CN domain identity, intra-domain NAS node selector, NAS message}* Same as figure 2 line 27.	MS→GERAN RRC RB3 (FACCH/S)
30	Initial UE message *{CN domain indicator, LAI, RAC, SAI, NAS-PDU, Iu signalling-connection identifier, Global RNC-ID}* Same as figure 2 line 28.	GERAN→CN RANAP *Iu-ps*
31	PMM-Connected The core network enters *PMM-Connected state*.	
36	**Sequence 1b** Lloyd receives an order confirmation when an RRC connection and a PMM connection exist as a result of a previous packet-data transaction. The following initial conditions apply: • PMM is in *PMM-Connected state*. • MM is in *MM-Idle state*. • RRC is in *RRC-GRA_PCH state*. • MAC is in *MAC-Idle state*; the mobile station monitors a PCCCH.	
43	Initiate data transfer Same as line 8.	CN←TE
44	Data PDU Since the CN still has an *Iu* connection for this mobile station, it sends the INVITE request to GERAN via the RAB established for this purpose (RABx). The GERAN RRC determines it has no physical-layer resources assigned to the radio bearer that serves RABx.	GERAN←CN RANAP *Iu-cs*
45	Packet paging request *{page mode, persistence level, NLN, page info (TBF or dedicated, mobile identity, channel needed)}* Same as line 10 with the following exception: • An indication that GERAN initiated the page, perhaps with an associated GERAN-initiated paging cause.	MS←GERAN RRC PCCCH (PPCH)
47	Packet channel request *{establishment cause, random reference}* Same as line 12.	MS→GERAN MAC PCCCH (PRACH)
49	Packet uplink assignment *{page mode, persistence level, packet-request reference, channel-coding command, TLLI-block channel coding, packet timing advance, frequency parameters, allocation (uplink TFI assignment)}* Same as line 14.	MS←GERAN MAC PCCCH (PAGCH)
51	MAC-Shared The MS and GERAN MACs enter *MAC-Shared state.*	

53	Cell update *{U-RNTI, START list, AM_RLC error indication (RB2 or RB3), AM_RLC error indication (RB4 and upwards), cell-update cause, RB-timer indicator}* Same as figure 2 line 51.	MS→GERAN RRC RB1 (FACCH/S)
55	Packet downlink assignment *{page mode, persistence level, global TFI, MAC mode, RLC mode, control ack, timeslot allocation, packet timing advance, P0, BTS pwr-control mode, PR mode, frequency parameters, downlink TFI assignment, power-control parameters, TBF starting time, measurement mapping}* Same as line 20.	MS←GERAN MAC PACCH
57	Cell update confirm *{RRC transaction identifier, activation time, RRC state indicator, UTRAN DRX cycle length coefficient, RLC re-establish indicator (RB2 and RB3), RLC re-establish indicator (RB4 and upwards),* <channel and radio-resource configuration information elements (reams of information elements of dubious usefulness)>*}* Same as figure 1 line 53 with the following exceptions: • *RRC state indicator* specifies that the mobile station enter *RRC-Cell_Shared* state.	MS←GERAN RRC RB1 (FACCH/S)
59	RRC-Cell_Shared The MS and GERAN RRCs enter *RRC-Cell_Shared state*.	
61	Packet downlink assignment *{page mode, persistence level, G-RNTI, MAC mode, RLC mode, control ack, timeslot allocation, packet timing advance, P0, BTS pwr-control mode, PR mode, frequency parameters, downlink TFI assignment, power-control parameters, TBF starting time, measurement mapping}* Same as figure 1 line 94. If the *packet downlink assignment* at line 55 assigned a TBF for RBx, and the assigned TBF was used by FACCH/S for the cell update, this *packet downlink assignment* could be omitted.	MS→GERAN MAC PACCH
63	Data PDU GERAN forwards the data to the MS.	MS←GERAN PDCP RBx (PDTCH)
75	**Sequence 2a** While engaged in the packet-data transaction from sequence 1a or 1b, Lloyd receives a packet voice call. The following conditions apply: • PMM is in *PMM-Connected state*. • MM is in *MM-Idle state*. • RRC is in *RRC-Cell_Shared state*. • MAC is in *MAC-Shared state*.	
76	INVITE request Same as figure 2 line 8.	CN←TE SIP
77	RAB assignment request *{RABs to be setup or modified}* Since no RAB exists for this PDP context, the CN establishes a new RAB (RABx). • *RABs to be setup or modified* proposes configuration parameters for the new RAB.	GERAN←CN RANAP *Iu-ps*
78	Radio bearer setup *{RRC transaction identifier, starting time, RRC state identifier, GERAN split paging cycle, RB parameters, physical-layer parameters, PDTCH parameters}* Since the GERAN RRC is in *RRC-Cell_Shared state* for this IMSI, it does not have to page the mobile station. Since no radio bearer exists for the radio access bearer, RRC configures a radio bearer (RBx) to carry the data. • <specify parameter settings.>	MS←GERAN RRC RB2 (FACCH/S)
80	Radio bearer setup complete *{RRC transaction identifier, RB parameters}* The MS RRC confirms configuration of the radio bearer. • <specify parameter settings.>	MS→GERAN RRC RB2 (FACCH/S)

81	RAB assignment response *{RABs setup or modified}* GERAN responds that RABx has been setup. • *RABs setup or modified* confirms the configuration parameters used for the new RAB.	GERAN→CN RANAP *Iu-ps*
83	INVITE request The CN sends the INVITE request to GERAN via the RAB established for this purpose (RABx). The GERAN RRC determines it has no physical-layer resources assigned to the radio bearer that serves RABx.	GERAN←CN GTP RABx (*Iu-ps*)
84	Packet dedicated assignment *{<parameters>}* The GERAN RRC has MAC assign a dedicated channel. • <specify parameter settings.>	MS←GERAN MAC PACCH
86	RRC-Cell_Dedicated The MS and GERAN RRCs enter *RRC-Cell_Dedicated state*.	
88	MAC-DTM The MS and GERAN MACs enter *MAC-DTM state*.	
90	INVITE request GERAN delivers the INVITE request to the mobile station.	MS←GERAN PDCP RBx (PDTCH)
94	**Sequence 2b** While engaged in the packet-data transaction from sequence 1a or 1b, Lloyd receives a packet voice call. The following conditions apply: • PMM is in *PMM-Connected state*. • MM is in *MM-Idle state*. • RRC is in *RRC-Cell_Shared state*. • MAC is in *MAC-Idle state*.	
95	INVITE request Same as line 76.	CN←TE SIP
96	RAB assignment request *{RABs to be setup or modified}* Same as line 77.	GERAN←CN RANAP *Iu-ps*
97	Packet dedicated assignment *{<parameters>}* Based on information received in the *RAB assignment request*, the GERAN RRC determines that a dedicated channel is the best choice and has MAC assign a dedicated channel. • <specify parameter settings.> <Can this message assign a dedicated channel for a radio bearer (RBx) that will be setup at line 103? Until RBx is setup, RRC could use the FACCH for RB2 signalling.>	MS←GERAN MAC PCCCH
99	RRC-Cell_Dedicated The MS and GERAN RRCs enter *RRC-Cell_Dedicated state*.	
101	MAC-Dedicated The MS and GERAN MACs enter *MAC-Dedicated state*.	
103	Radio bearer setup *{RRC transaction identifier, starting time, RRC state identifier, GERAN split paging cycle, RB parameters, physical-layer parameters, PDTCH parameters}* Same as line 78 with the following exceptions: • RRC is in *RRC-Dedicated state*.	MS←GERAN RRC RB2 (FACCH)
105	Radio bearer setup complete *{RRC transaction identifier, RB parameters}* Same as line 80.	MS→GERAN RRC RB2 (FACCH)

106	RAB assignment response *{RABs setup or modified}* Same as line 81.	GERAN→CN RANAP *Iu-ps*
108	INVITE request The CN sends the INVITE request to GERAN via the RAB established for this purpose (RABx).	GERAN←CN GTP RABx (*Iu-ps*)
109	INVITE request Same as line 90.	MS←GERAN PDCP RBx (PDTCH)
113	**Sequence 2c** While engaged in the packet-data transaction from sequence 1a or 1b, Lloyd receives a circuit voice call. The following conditions apply: • PMM is in *PMM-Connected state*. • MM is in *MM-Idle state*. • RRC is in *RRC-Cell_Shared state*. • MAC is in *MAC-Shared state*.	
114	Initiate voice call Same as figure 1 line 8.	CN←TE
115	Paging *{CN domain indicator, permanent NAS UE identity, temporary UE identity, paging area ID, paging cause, non-searching indication, DRX cycle-length coefficient}* Same as figure 1 line 9.	GERAN←CN RANAP *Iu-cs*
116	Packet dedicated assignment *{<parameters>}* Same as figure 1 line 14.	MS←GERAN MAC PACCH
118	RRC-Cell_Dedicated The MS and GERAN RRCs enter *RRC-Cell_Dedicated state*.	
120	MAC-DTM The MS and GERAN MACs enter *MAC-DTM state*.	
122	Dedicated paging request *{RRC transaction identifier, paging cause, CN domain identity, paging record type identifier}* Since the GERAN RRC is in *RRC-Cell_Dedicated* state for this IMSI, it knows where the mobile station is and it has radio bearers established to that mobile station. It therefore sends a CN-initiated *dedicated paging request* on RB2. Upon receipt of the *dedicated paging request*, the MS RRC informs its non-access stratum that the core network has paged it. The MS NAS responds to the page. • *RRC transaction identifier* identifies the transaction. Subsequent messages in the transaction use this identifier. • *Paging cause* indicates *terminating conversational call.* • *CN domain identity* indicates *circuit domain.* • *Paging record type identifier* indicates *TMSI*.	MS←GERAN RRC RB2 (SDCCH)
124	Initial direct transfer *{CN domain identity, intra-domain NAS node selector, NAS message}* Same as figure 1 line 27.	MS→GERAN RRC RB3 (SDCCH)
125	Initial UE message *{CN domain indicator, LAI, SAI, NAS-PDU, Iu signalling-connection identifier, Global RNC-ID}* Same as figure 1 line 28.	GERAN→CN RANAP *Iu-cs*
126	MM-Connected The core network enters MM-Connected state.	

131	**Sequence 2d** While engaged in the packet-data transaction from sequence 1a or 1b, Lloyd receives a circuit voice call. The following conditions apply: • PMM is in *PMM-Connected state*. • MM is in *MM-Idle state*. • RRC is in *RRC-Cell_Shared state*. • MAC is in *MAC-Idle state*.	
132	Initiate voice call Same as line 114.	CN←TE
133	Paging *{CN domain indicator, permanent NAS UE identity, temporary UE identity, paging area ID, paging cause, non-searching indication, DRX cycle-length coefficient}* Same as line 115.	GERAN←CN RANAP *Iu-cs*
134	Packet dedicated assignment *{<parameters>}* Same as line 116. Sequence 2c and sequence 2d differ as follows: GERAN sends the *packet dedicated assignment* on PACCH in 2c and PPCH in 2d.	MS←GERAN MAC PCCCH (PPCH)
136	RRC-Cell_Dedicated The MS and GERAN RRCs enter *RRC-Cell_Dedicated state*.	
138	MAC-DTM The MS and GERAN MACs enter *MAC-DTM state*.	
140	Dedicated paging request *{RRC transaction identifier, paging cause, CN domain identity, paging record type identifier}* Same as line 122.	MS←GERAN RRC RB2 (SDCCH)
142	Initial direct transfer *{CN domain identity, intra-domain NAS node selector, NAS message}* Same as line 124.	MS→GERAN RRC RB3 (SDCCH)
143	Initial UE message *{CN domain indicator, LAI, SAI, NAS-PDU, Iu signalling-connection identifier, Global RNC-ID}* Same as line 125.	GERAN→CN RANAP *Iu-cs*
144	MM-Connected The core network enters MM-Connected state.	

3. Impact on specifications

This section is incomplete. This section should be revisited when previous sections stabilize.

3.1 Changes to 23.060 (GPRS stage 2)

Section	Description
	<Are we going to update this standard or leave it alone?>

3.2 Changes to 24.008 (CN protocols)

Section	Description
9.2.15	Location updating request Add *DRX parameter*. *DRX parameter* is already specified in § 10.5.5.6.
10.5.1.4	Mobile identity Add G-RNTI as a *mobile identity*.

3.3 Changes to 25.413 (UTRAN RANAP)

Section	Description
3.3	Abbreviations Add GERAN. Add *mobile station* to definition of UE.
8.15	Paging Update section to include GERAN paging. Add *SPLIT_PG_CYCLE.*
9.1.23	Paging Add *SPLIT_PG_CYCLE.*
9.2	Information-element definitions Add *SPLIT_PG_CYCLE.*

3.4 Changes to 44.018 (GERAN RRC)

This section proposes changes to GP-011262 (*Draft CR to 44.018 due to RRC Part 1* [Nokia]) and GP-011196 (*Draft CR to 44.018 due to RRC Part 2* [Nokia]).

<This section will have to be updated to reflect the structure of 44.118.>

Section	Description
3.3.2.1	Paging initiation by the network <Do we need to specify what to do with new information elements in the *paging requests*?>
3.3.2.2	Paging response <Changes to this section specify the following: In *Iu mode*, the upper layer is informed that RRC entity entered the *RRC-Cell_Dedicated* state. RRC does not enter this state until the RRC connection is established, long after the paging response.>
3.5.1.1	Packet paging initiation by the network <Do we need to specify what to do with new information elements in the *packet paging request*?>
3.4	Procedures in RR dedicated mode … Add subsection specifying paging in *RRC-Cell_Dedicated* state. See 25.331 § 8.1.11, *UE dedicated paging.* <How does this relate to 44.018 § 3.4.22.2, *Packet notification procedure in dedicated mode*?>
9.1	Paging Add a paging message based on 25.331 *paging type 2.*
9.1.22	Paging request type 1 For both mobile identities, add the following to the *paging request type 1:* • An implicit indication of which network element initiated the page: CN or GERAN. The presence of *paging cause* indicates a CN-initiated page; the absence of *paging cause* indicates a GERAN-initiated page. This requires that GERAN fabricate a *paging cause* if the CN does not provide a *paging cause* in the RANAP *paging* message. • An indication of which core network initiated the page: circuit-domain or packet-domain. If paging with IMSI, include this element. If paging with P-TMSI or TMSI, omit the element since the identity implicitly indicates the network initiating the page. • *Paging cause* from the RANAP *paging* message. <Do we have enough message length to modify *paging request type 1, type 2,* and *type 3*? If not, we may want to define a new *Iu-mode* paging message.>
9.1.23	Paging request type 2 Add the following to the *paging request type 2:* • For mobile identities 1 through 3, an implicit indication of which network element initiated the page: CN or GERAN. • For *mobile identity 3*, an indication of which core network initiated the page: circuit-domain or packet-domain. If paging with IMSI, include this element. If paging with P-TMSI or TMSI, omit the element since the identity implicitly indicates the network initiating the page. • For mobile identities 1 through 3, p*aging cause* from the RANAP *paging* message.
9.1.24	Paging request type 3 For all four mobile identities, add the following to the *paging request type 3:* • An implicit indication of which network element initiated the page: CN or GERAN. • *Paging cause* from the RANAP *paging* message.
10.5.2.23	P1 rest octets *Packet page indication i* applies when paging with G-RNTI. Delete the requirement that *Packet page indication i* be ignored if the mobile identity is not IMSI.
10.5.2.24	P2 rest octets *Packet page indication 3* applies when paging with G-RNTI. Delete the requirement that *Packet page indication 3* be ignored if the mobile identity is not IMSI.
	Add a procedure for physical-channel reconfiguration. Add a *physical-channel reconfiguration* message based on the 25.331 message of the same name. Add a *physical-channel reconfiguration complete* message based on the 25.331 message of the same name.

3.5 Changes to 44.060 (GERAN RLC/MAC)

Section	Description
6	Paging procedures Change title to *Paging procedures in A/Gb mode*.
6a	Add new section: *Paging procedures in Iu mode*.
11.2.10	Packet paging request Add the following information elements to the *packet paging request*: • An implicit indication of which network element initiated the page: CN or GERAN. The presence of *paging cause* indicates a CN-initiated page; the absence of *paging cause* indicates a GERAN-initiated page. This requires that GERAN fabricate a *paging cause* if the CN does not provide a *paging cause* in the RANAP *paging* message. • An indication of which core network initiated the page: circuit-domain or packet-domain. If paging with IMSI, include this element. If paging with P-TMSI or TMSI, omit the element since the identity implicitly indicates the network initiating the page. • *Paging cause* from the RANAP *paging* message. • G-RNTI as a *mobile identity*. Change the following: • Support paging with P-TSMI for RR connection establishment.
12	Information-element coding

3.6 Changes to 45.002 (L1 Multiplexing)

Section	Description
6.5.6	Determination of PCCCH_GROUP and PAGING_GROUP for MS in GPRS attached mode Specify that this section applies to mobile stations operating in *Iu mode*.

4. References

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3. 3GPP TS 24.008. *3rd Generation Partnership Project; Technical Specification Group Core Network; Mobile radio interface layer 3 specification; Core Network Protocols - Stage 3.*

4. 3GPP TS 25.304. *3rd Generation Partnership Project; Technical Specification Group Radio Access Network; UE Procedures in Idle mode and Procedures for Cell Reselection in Connected Mode.*

5. 3GPP TS 25.331. *3rd Generation Partnership Project; Technical Specification Group Radio Access Network; RRC Protocol Specification.*

6. 3GPP TS 25.413. *3rd Generation Partnership Project; Technical Specification Group Radio Access Network; UTRAN Iu interface RANAP signalling.*

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9. 3GPP TS 44.060. *3rd Generation Partnership Project; Technical Specification Group GSM EDGE Radio Access Network; General Packet Radio Service (GPRS); Mobile Station (MS) – Base Station System (BSS) interface; Radio Link Control / Medium Access Control (RLC/MAC) protocol.*

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11. ITU-T X.200. *Information Technology – Open Systems Interconnection – Basic Reference Model: The Basic Model.* Geneva: International Telecommunication Union, July 1994.

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14. ITU-T Z.120. *Message Sequence Chart (MSC).* Geneva: International Telecommunication Union, March 1993.

15. G2-010063. *GERAN Iu paging procedures.* Helsinki: Ericsson, 25 Jun 01.

16. GAHW-010241. *Results of RLC/MAC drafting meeting.* Bellevue: GERAN Ad Hoc, 07 May 01.

17. GP-010679. *Analysis of GERAN Iu-mode paging scenarios.* Biarritz: Lucent, 02 Apr 01.

A. Network-operation modes

A.1 GPRS

GRPS operates in one of three modes:

- *Mode I* has a *Gs* interface between MSC and SGSN. For mobile stations attached to both domains, the MSC sends circuit pages via the SGSN, *i.e.*, a BSSGP paging message on the *Gb* interface. The SGSN sends packet pages directly to the BSS, *i.e.*, a BSSGP paging message on the *Gb* interface. The BSS pages the mobile station via the following channel: PACCH if available, else PCCCH if available, else CCCH.

- *Mode II* has no *Gs* interface between MSC and SGSN. The MSC sends circuit pages directly to the BSS, *i.e.*, a BSSAP paging message on the *A* interface. The SGSN sends circuit pages directly to the BSS, *i.e.*, a BSSGP paging message on the *Gb* interface. The BSS pages the mobile station via the CCCH.

- *Mode III* has no *Gs* interface between MSC and SGSN. The MSC sends circuit pages directly to the BSS, *i.e.*, a BSSAP paging message on the *A* interface. The SGSN sends circuit pages directly to the BSS, *i.e.*, a BSSGP paging message on the *Gb* interface. The BSS sends circuit pages via the CCCH. It sends packet pages via the PCCCH if available, else CCCH.

A.2 UMTS

UMTS operates in one of two modes:

- *Mode I* has a *Gs* interface between MSC and SGSN. For mobile stations attached to both domains, the MSC sends circuit pages via the SGSN, *i.e.*, a RANAP paging message on the *Iu-ps* interface. The SGSN sends packet pages directly to UTRAN, *i.e.*, a RANAP paging message on the *Iu-ps* interface.

- Mode II has no *Gs* interface between MSC and SGSN. The MSC sends circuit pages directly to UTRAN, *i.e.*, a RANAP paging message on the *Iu-cs* interface. The SGSN sends packet pages directly to UTRAN, *i.e.*, a RANAP paging message on the *Iu-ps* interface.

A.3 GERAN

This concept paper proposes that GERAN operate in any one of the following modes:

- *Mode I* has a *Gs* interface between MSC and SGSN. For mobile stations attached to both domains, the MSC sends circuit pages via the SGSN, *i.e.*, a RANAP paging message on the *Iu-ps* interface. The SGSN sends packet pages directly to the GERAN, *i.e.*, a RANAP paging message on the *Iu-ps* interface. GERAN pages the mobile station via the following channel: PACCH if available, else PCCCH.

- *Mode II* has no *Gs* interface between MSC and SGSN. The MSC sends circuit pages directly to GERAN, *i.e.*, a RANAP paging message on the *Iu-cs* interface. The SGSN sends packet pages directly to GERAN, *i.e.*, a RANAP paging message on the *Iu-ps* interface. GERAN pages the mobile station via the following channel: PACCH if available, else PCCCH.

  <If the mobile station signals DRX parameters at circuit-domain attach and location-area update, why do we need *mode I*?>

B. Paging equations

This annex describes several complicated methods of hashing mobile stations over available paging channels. Why wasn't one simple method good enough? It's not the ETSI/3GPP way: never use a nail when you can specify multidimensional impact-inserted flexible attachment functionality.

B.1 CCCH

3GPP TS 45.002 [10] specifies the information on which these equations are based.

B.1.1 Paging blocks per CCCH multiframe (N_m)

The following equation calculates the number of paging blocks per CCCH 51-multiframe.

$$N_m = 9 - 6 * BS\_CCCH\_SDCCH\_COMB - BS\_AG\_BLKS\_RES$$

where:

N_m	=	number of paging blocks per CCCH 51-multiframe.
BS_CCCH_SDCCH_COMB	=	SDCCH combined with CCCH (1) or not (0). Broadcast variable (*CCCH_CONF*).
BS_AG_BLKS_RES	=	number of blocks per common control channel not available for paging (0 to 7). Broadcast variable.

B.1.2 Paging blocks per CCCH (N_c, M_c)

For GPRS-detached mobile stations, the following equation calculates the number of paging blocks per CCCH.

$$N_c = BS\_PA\_MFRMS * N_m$$

where:

N_c	=	number of paging blocks per common control channel.
BS_PA_MFRMS	=	number of 51-multiframes between pages to the same mobile station (2 to 9). Broadcast variable.
N_m	=	number of paging blocks per CCCH 51-multiframe.

For GPRS-attached mobile stations, the following equation calculates the number of packet paging blocks per CCCH. If the CCCH does not support this type of paging, the preceding equation applies.

$$M_c = 64 * N_m$$

where:

M_c	=	number of packet paging blocks per common control channel.
N_m	=	number of paging blocks per CCCH 51-multiframe.

B.1.3 Paging blocks per cell (N_t, M_t)

For GPRS-detached mobile stations, the following equation calculates the number of paging blocks for all common control channels in a cell.

$$N_t = BS\_CC\_CHANS * N_c$$

where:

N_t	=	total number of paging blocks per cell.
BS_CC_CHANS	=	number of common control channels (1 to 4). Broadcast variable (*CCCH_CONF*).
N_c	=	number of paging blocks per common control channel.

For GPRS-attached mobile stations, the following equation calculates the number of packet paging blocks for all common control channels in a cell. If the CCCH does not support this type of paging, the preceding equation applies.

$$M_t = BS\_CC\_CHANS * M_c$$

where:

M_t	=	total number of packet paging blocks per cell.
BS_CC_CHANS	=	number of common control channels (1 to 4). Broadcast variable (*CCCH_CONF*).
M_c	=	number of packet paging blocks per common control channel.

B.1.4 Monitored CCCH

The following equation calculates which CCCH a mobile station shall monitor.

$$CCCH\_GROUP = \left[(IMSI \bmod 1000) \bmod N_t \right] \operatorname{div} N_c$$

where:

$CCCH\_GROUP$	=	the common control channel to be monitored by the mobile station (0 to $BS\_CC\_CHANS - 1$).
$IMSI$	=	international mobile-subscriber identity.
N_t	=	total number of paging blocks per cell.
N_c	=	number of paging blocks per common control channel.

<Why does this hash function require three modulo or div operations instead of just one modulo operation based on the number of CCCHs, *i.e.*, $CCCH\_GROUP = IMSI \bmod BS\_CC\_CHANS$?>

B.1.5 Monitored paging block on CCCH

For GPRS-detached mobile stations, the following equation calculates which paging block to monitor on the monitored common control channel.

$$PAGING\_GROUP = \left[(IMSI \bmod 1000) \bmod N_t\right] \bmod N_c$$

where:

$PAGING\_GROUP$	=	the group of paging blocks the mobile station shall monitor.
$IMSI$	=	international mobile-subscriber identity.
N_t	=	total number of paging blocks per cell.
N_c	=	number of paging blocks per common control channel.

For GPRS-attached mobile stations, the following equation calculates which paging block to monitor on the monitored common control channel. If the CCCH does not support this type of paging, the preceding equation applies.

$$PAGING\_GROUP = \begin{pmatrix} \left[(IMSI \bmod 1000) \operatorname{div} N_t\right] * N_c + \\ (IMSI \bmod 1000) \bmod N_c + \\ \max\left[(m * M_c) \operatorname{div} SPLIT\_PG\_CYCLE, m\right] \end{pmatrix} \bmod M_c$$

where:

$PAGING\_GROUP$	=	the group of paging blocks the mobile station shall monitor.
$IMSI$	=	international mobile-subscriber identity.
N_t	=	total number of paging blocks per cell.
N_c	=	number of paging blocks per common control channel.
m	=	0, 1 … min (M_c, *SPLIT_PG_CYCLE*) – 1.
M_c	=	number of packet paging blocks per common control channel.
$SPLIT\_PG\_CYCLE$	=	the divisor for the period between pages to a mobile station, where the period is expressed in M_c packet paging blocks, *e.g.*: if *SPLIT_PG_CYCLE* = 1, GERAN will page the mobile station every M_c blocks (every 64 multiframes); if *SPLIT_PG_CYCLE* = 2, GERAN will page the mobile station every $M_c/2$ blocks (every 32 multiframes); if *SPLIT_PG_CYCLE* = 64, GERAN will page the mobile station every $M_c/64$ blocks (every multiframe). Any time *SPLIT_PG_CYCLE* is set greater than or equal to M_c, GERAN will page the mobile station in every packet paging block. GERAN and the mobile station establish the value of *SPLIT_PG_CYCLE* during GPRS attach. *SPLIT_PG_CYCLE* can take one of the following values: 1 to 64, 71, 72, 74 … 352, 704. For the CCCH, *SPLIT_PG_CYCLE* is not allowed to exceed 32.

B.1.6 Paging multiframe

For GPRS-detached mobile stations, when the following equation is true, the mobile station may be paged within the multiframe containing *FN*.

$$PAGING\_GROUP \text{ div } N_{\mathrm{m}} = (FN \text{ div } 51) \bmod (BS\_PA\_MFRMS)$$

where:

PAGING_GROUP	=	the group of paging blocks the mobile station shall monitor.
N_{m}	=	number of paging blocks per CCCH 51-multiframe.
FN	=	frame number.
BS_PA_MFRMS	=	number of 51-multiframes between pages to the same mobile station (2 to 9). Broadcast variable.

For GPRS-attached mobile stations, when the following equation is true, the mobile station may be paged within the multiframe containing *FN*. If the CCCH does not support this type of paging, the preceding equation applies.

$$PAGING\_GROUP \text{ div } N_{\mathrm{m}} = (FN \text{ div } 51) \bmod 64$$

where:

PAGING_GROUP	=	the group of paging blocks the mobile station shall monitor.
N_{m}	=	number of paging blocks per CCCH 51-multiframe.
FN	=	frame number.

B.1.7 Paging-block index (*i*)

The following equation calculates the index to the paging block in which the mobile station may be paged, *i.e.*, a calculated value of 0 indicates B0 (block 0).

$$i = PAGING\_GROUP \bmod N_{\mathrm{m}}$$

where:

i	=	the index to the paging block within the 51-multiframe.
PAGING_GROUP	=	the group of paging blocks the mobile station shall monitor.
N_{m}	=	number of paging blocks per CCCH 51-multiframe.

B.2 PCCCH

3GPP TS 45.002 [10] specifies the information on which these equations are based.

B.2.1 Paging blocks per PCCCH multiframe (N_{pm})

The following equation calculates the number of paging blocks per PCCCH 52-multiframe.

$$N_{pm} = 12 - BS\_PAG\_BLKS\_RES - BS\_PBCCH\_BLKS$$

where:

N_{pm}	=	number of paging blocks per PCCCH 52-multiframe.
BS_PAG_BLKS_RES	=	number of blocks per PCCCH not available for paging (0 to 12). Broadcast variable.
BS_PBCCH_BLKS	=	number of blocks per 52-multiframe reserved for PBCCH. Broadcast variable.

B.2.2 Paging blocks per PCCCH (M_{pc})

The following equation calculates the number of paging blocks per PCCCH.

$$M_{pc} = 64 * N_{pm}$$

where:

M_{pc}	=	number of paging blocks per PCCCH.
N_{pm}	=	number of paging blocks per PCCCH 52-multiframe.

B.2.3 Paging blocks per cell (N_{pt})

The following equation calculates the number of paging blocks for all PCCCHs in a cell.

$$N_{pt} = BS\_PCC\_CHANS * M_{pc}$$

where:

N_{pt}	=	total number of paging blocks per cell.
BS_PCC_CHANS	=	number of PCCCHs (1 to 16). Broadcast variable.
M_{pc}	=	number of paging blocks per PCCCH.

B.2.4 Monitored PCCCH

The following equation calculates which PCCCH a mobile station shall monitor.

$$PCCCH\_GROUP = (IMSI \bmod 1000) \bmod BS\_PCC\_CHANS$$

where:

PCCCH_GROUP	=	the PCCCH to be monitored by the mobile station (0 to *BS_PCC_CHANS* – 1).
BS_PCC_CHANS	=	number of PCCCHs (1 to 16). Broadcast variable.

B.2.5 Monitored paging block on PCCCH

The following equation calculates which paging block a GPRS-attached mobile station shall monitor on the monitored PCCCH.

$$PAGING\_GROUP = \begin{pmatrix} \left[(IMSI \bmod 1000) \operatorname{div} N_{pt}\right] * N_{pc} + \\ (IMSI \bmod 1000) \bmod N_{pc} + \\ \max\left[(m * M_{pc}) \operatorname{div} SPLIT\_PG\_CYCLE, m\right] \end{pmatrix} \bmod M_{pc}$$

where:

$PAGING\_GROUP$ = the group of packet paging blocks the mobile station shall monitor.

$IMSI$ = international mobile-subscriber identity.

N_{pt} = total number of packet paging blocks per cell.

N_{pc} = number of paging blocks per PCCCH.

m = 0, 1 … min (M_{pc}, $SPLIT\_PG\_CYCLE$) – 1.

M_{pc} = number of paging blocks per PCCCH.

$SPLIT\_PG\_CYCLE$ = the divisor for the period between pages to a mobile station, where the period is expressed in M_{pc} packet paging blocks

B.2.6 Paging multiframe

When the following equation is true, the mobile station may be paged within the multiframe containing *FN*.

$$PAGING\_GROUP \operatorname{div} N_{pm} = (FN \operatorname{div} 52) \bmod 64$$

where:

$PAGING\_GROUP$ = the group of paging blocks the mobile station shall monitor.

N_{pm} = number of paging blocks per PCCCH 52-multiframe.

FN = frame number.

B.2.7 Paging-block index (*i*)

The following equation calculates the index to the paging block in which the mobile station may be paged, *i.e.*, a calculated value of 0 indicates B0 (block 0).

$$i = PAGING\_GROUP \bmod N_{pm}$$

where:

i = the index to the paging block within the 52-multiframe.

$PAGING\_GROUP$ = the group of paging blocks the mobile station shall monitor.

N_{pm} = number of paging blocks per PCCCH 52-multiframe.

B.3 UTRAN

The following equation calculates the system frame number of the first frame of the paging block in which the mobile station will be paged [4].

$$P = [(IMSI \text{ div } K) \text{ mod}(DRX \text{ div } PBP) * PBP] + [n * DRX] + Fo$$

where:

P = system frame number of the first frame of the paging block in which the mobile station will be paged.

IMSI = international mobile-subscriber identity.

K = number of paging channels.

DRX = DRX cycle length calculated as follows: $DRX = \max(2^k, PBP)$, where *k* is the *DRX cycle-length coefficient* (an integer from 6 to 9) and *PBP* is the paging block period specified below. Also, see the discussion in § B.4.

PBP = paging block period. *PBP* = 1 for frequency-division duplex.

n = non-negative integer.

Fo = frame offset.

B.4 DRX values for UTRAN

In *RRC Idle* mode, the UE shall use the following for *DRX:*

- The stored DRX cycle length for any CN domain to which the UE is attached. <Shouldn't the UE use the shortest DRX cycle length?>

In *RRC Connected* mode, the UE shall use the shortest of the following for *DRX*:

- The UTRAN DRX cycle length calculated using the *UTRAN DRX cycle-length coefficient*. This coefficient appears in several RRC messages, *e.g.*, *Radio-Bearer Setup* and *Radio-Bearer Reconfiguration*.

- The stored DRX cycle length for any CN domain to which the UE is attached but not connected. <Shouldn't this be the shortest stored DRX cycle length, not any stored value?>

The UE could be attached to two CN domains, circuit and packet, each having their own DRX cycle lengths. For the circuit domain, the UE uses the circuit-domain *CN-domain-specific DRX cycle-length coefficient* broadcast in system information. For the packet domain, the UE negotiates the DRX cycle length during attachment. If no DRX cycle length has been negotiated, the UE uses the packet-domain *CN-domain-specific DRX cycle-length coefficient* broadcast in system information.

C. States

This annex plagiarizes GP-010679 [17] and G2-010063 [15].

C.1 MM states

Mobility management applies to the circuit domain. One MM state machine resides in each mobile station. For each mobile station, one MM state machine resides in the core network. The MM state machine has the following states:

- *MM-Detached.*
  The core network cannot reach the mobile station for circuit services.

- *MM-Idle.*
  The core network can reach the mobile station via paging. No *Iu-cs* or RRC connection exists.

- *MM-Connected.*
  The core network supplies circuit services via a signalling connection between the core network and the mobile station. A signalling connection comprises a RRC connection between MS and GERAN and an *Iu-cs* connection between GERAN and CN.

C.2 PMM states

Packet mobility management applies to the packet domain. One PMM state machine resides in each mobile station. For each mobile station, one PMM state machine resides in the core network. The PMM state machine has the following states:

- *PMM-Detached.*
  The core network cannot reach the mobile station for packet services.

- *PMM-Idle.*
  The core network can reach the mobile station via paging. No *Iu-ps* or RRC connection exists.

- *PMM-Connected.*
  The core network supplies packet services via a signalling connection between the core network and the mobile station. A signalling connection comprises a RRC connection between MS and GERAN and an *Iu-ps* connection between GERAN and CN.

C.3 RCC modes

Radio-resource control applies to the circuit and packet domains. One RRC state machine resides in each mobile station. For each mobile station, one RRC state machine resides in the GERAN. The RRC state machine has two high-level states — for some obscure reason, called modes:

- *RRC-Idle.*
  No RRC connection exists between mobile station and GERAN. GERAN may be able to reach the mobile station via paging. In this state (mode), both of the following will be true: MM is not in *MM-Connected state*; PMM is not in *PMM-Connected state*.

  Upon receipt of a RANAP *paging* message, GERAN pages the mobile station using a core-network identifier (IMSI, TSMI, or P-TMSI). Paging triggers the mobile station to establish an RRC connection and then send an NAS (non-access stratum) paging response to the core network.

  If the mobile station camps on a CCCH, RRC pages the mobile station. If the mobile station camps on PCCCH, RRC requests that MAC page the mobile station.

- *RRC-Connected.*
  A signalling connection exists between mobile station and GERAN. In this state (mode), one or more of the following will be true: MM is in *MM-Connected state*; PMM is in *PMM-Connected state*.

C.4 RRC states

In *RRC Connected* mode, RRC is in one of the following states:

- *RRC-GRA_PCH.*
  GERAN knows the mobile-station location to a GRA (GERAN registration area). RRC has allocated no physical subchannels.

  Upon receipt of a RANAP *paging* message, GERAN pages the mobile station using a GERAN identifier (G-RNTI). Paging triggers the mobile station to perform a cell update and then send an NAS paging response to the core network.

  Upon receipt of a downlink PDU, GERAN pages the mobile station using a GERAN identifier (G-RNTI). Paging triggers the mobile station to perform a cell update. Once GERAN knows which cell serves the mobile station, it forwards the downlink PDU.

  If the mobile station camps on a CCCH, RRC pages the mobile station. If the mobile station camps on PCCCH, RRC requests that MAC page the mobile station.

- *RRC-Cell_Shared.*
  GERAN knows the mobile-station location to the cell where the mobile station last performed a cell update. RRC has allocated no dedicated physical subchannels. It has allocated zero (*MAC Idle* state), one (*MAC Shared* state), or more (*MAC Shared* state) shared physical subchannels.

  Upon receipt of a RANAP *paging* message, GERAN pages the mobile station using a GERAN identifier (G-RNTI). Paging triggers the mobile station to send an NAS paging response to the core network. <Should the mobile station perform a cell update? If so, why?>

  Upon receipt of a downlink PDU, GERAN forwards the downlink PDU.

  If the mobile station is in *MAC Shared* state, it monitors PACCH, and RRC performs paging. If the mobile station is in *MAC Idle* state and it camps on a CCCH, RRC performs paging. If the mobile station is in *MAC Idle* state and it camps on a PCCCH, RRC requests that MAC page.

- *RRC-Cell_Dedicated.*
  GERAN knows the mobile-station location to a cell. RRC has allocated one or more dedicated physical subchannels and zero or more shared physical subchannels.

  Upon receipt of a RANAP *paging* message, GERAN pages the mobile station using a GERAN identifier (G-RNTI). Paging triggers the mobile station to send an NAS paging response to the core network.

  Upon receipt of a downlink PDU, GERAN forwards the downlink PDU.

  RRC pages the mobile station using a dedicated control channel.