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Illustrative Evidence of Use Charts

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Illustrative Evidence of Use

U.S. Patent No. US 8,908,633	**R11**	**ePDCCH**	**Page 3 - 9**
U.S. Patent No. US 8,576,794	**R11**	**ePDCCH**	**Page 10 - 16**
U.S. Patent No. US 8,427,976	**R13**	**NCT**	**Page 17 - 26**
EP Patent No. EP 2564612 A1	**R11**	**ePDCCH**	**Page 27 - 35**

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Illustrative Evidence of Use
U.S. Patent No. US 8,908,633
for R11 ePDCCH

This Illustrative Evidence of Use chart is one of many example scenarios.

Patent no.: US 8,908,633

Title: Control and Data Channel Radio Resource Configuration

Priority Date: July 1st , 2011

Status: Issued

Number of Claims: 3 independent claims, 17 dependent claims

Summary: Claims are standard essential and are applicable to LTE Release-11 wireless devices and base stations.

Example Claim:

Claim 1: A method for use in a base station, the method comprising:

a) transmitting on a first control channel, to a wireless device, first scheduling information for a radio resource control (RRC) message, first radio resources of said first control channel in a subframe in a plurality of subframes starting from the first OFDM symbol of said subframe;

b) transmitting, to said wireless device, said RRC message comprising configuration parameters of second radio resources of a second control channel, said second radio resources comprising one or more sets of resource blocks in a subset of subframes in said plurality of subframes, said RRC message indicating:

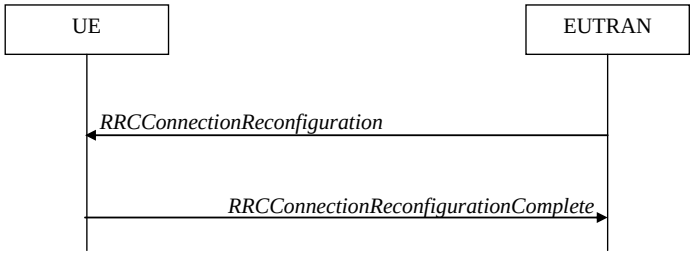
   i) said subset of subframes in which said second radio resources are configured; and

   ii) a first starting OFDM symbol of both said second control channel and a data channel in said subset of subframes, said first starting symbol being applicable to each subframe in said subset of subframes indicated in said RRC message; and

c) transmitting, to said wireless device, second scheduling information on said second control channel for a packet transmitted on said data channel.

Claim 1	Standard/Product	Comments
A method for use in a base station, the method comprising:		The method applies to a Release-11 LTE base station.
a) transmitting on a first control channel, to a wireless device, first scheduling information for a radio resource control (RRC) message, first radio resources of said first control channel in a subframe in a plurality of subframes starting from the first OFDM symbol of said subframe;	**Ref [1]** **5 Physical Layer for E-UTRA** **Physical downlink control channel (PDCCH)** - Informs the UE and the RN about the resource allocation of PCH and DL-SCH, and Hybrid ARQ information related to DL-SCH; **5.1.3 Physical downlink control channel** The downlink control signalling (PDCCH) is located in the first *n* OFDM symbols where $n \leq 4$ and consists of: - Transport format and resource allocation related to DL-SCH and PCH, and hybrid ARQ information related to DL-SCH; **Ref [2]** – **RRCConnectionReconfiguration** The *RRCConnectionReconfiguration* message is the command to modify an RRC connection. It may convey information for measurement configuration, mobility control, radio resource configuration (including RBs, MAC main configuration and physical channel configuration) including any associated dedicated NAS information and security configuration. Signalling radio bearer: SRB1 RLC-SAP: AM Logical channel: DCCH Direction: E-UTRAN to UE **Ref [3]** **Table 4.5.3.2-1: Downlink channel mapping.** Transport channel / Logical channel: BCH, PCH, DL-SCH, MCH BCCH: X, X	A base station transmits scheduling information (resource allocation information) to a wireless device. First scheduling information is the transport format and resource allocation information transmitted to the wireless device. RRC Connection Reconfiguration message is transmitted on DCCH, which is mapped on DL-SCH. Before any EPDCCH is configured, the RRC message configuring the EPDCCH is transmitted on DL-SCH and is scheduled using scheduling information in PDCCH radio resources. PDCCH radio resources start from the first OFDM symbol of a subframe.

	PCCH	X		
	CCCH		X	
	DCCH		X	
	DTCH		X	
	MCCH			X
	MTCH			X

b) transmitting, to said wireless device, said RRC message comprising configuration parameters of second radio resources of a second control channel, said second radio resources comprising one or more sets of resource blocks in a subset of subframes in said plurality of subframes, said RRC message indicating:
 	
i) said subset of subframes in which said second radio resources are configured; and
 	
ii) a first starting OFDM symbol of both said second control channel and a data channel in said subset of subframes, said first starting symbol being applicable to each subframe in said subset of
	Ref [4]
	
	9.1.4 EPDCCH assignment procedure
	For each serving cell, higher layer signalling can configure a UE with one or two EPDCCH-PRB-sets for EPDCCH monitoring. The PRB-pairs corresponding to an EPDCCH-PRB-set are indicated by higher layers as described in section 9.1.4.4.
	
	Ref [2]
	
	5.3.5 RRC connection reconfiguration
	 
	
	Figure 5.3.5.1-1: RRC connection reconfiguration, successful
	
	6.3.2 Radio resource control information elements
	
	– EPDCCH-Config
	The IE EPDCCH-Config is used to configure the subframes and resource blocks for EPDCCH monitoring.
	
	EPDCCH-Config information element
	
	`EPDCCH-Config-r11 ::= SEQUENCE{`
	`epdcch-SubframePatternConfig-r11 CHOICE {`
	`release NULL,`
	`setup SEQUENCE {`
	`epdcch-SubframePattern-r11 MeasSubframePattern-r10`
	`}`
	`} OPTIONAL, -- Need ON`
		Base station transmits an RRC connection reconfiguration message. The RRC message causes configuration of EPDCCH (a control channel) and PDSCH (a data channel) in the wireless device compatible with release 11 or higher.
		
		EPDCCH is configured for a subset of subframes. RRC message indicates the subset of subframes using SubframePattern bitmap.
		
		Radio resources of EPDCCH comprise multiple sets of RBs.
		There could be up to two different sets of EPDCCH radio resources, each comprising many resource blocks.
		
		EPDCCH and PDSCH starts from epdcch-StartSymbol symbol in the subset of subframes.

subframes indicated in said RRC message; and	epdcch-StartSymbol-r11 INTEGER (1..4) OPTIONAL, -- Need OP
	epdcch-SetConfigReleaseList-r11 EPDCCH-SetConfigReleaseList-r11 OPTIONAL, -- Need ON
	epdcch-SetConfigAddModList-r11 EPDCCH-SetConfigAddModList-r11 OPTIONAL -- Need ON
	}
	EPDCCH-SetConfig-r11 ::= SEQUENCE {
	epdcch-SetIdentity-r11 EPDCCH-SetIdentity-r11,
	epdcch-TransmissionType-r11 ENUMERATED {localised, distributed},
	epdcch-ResourceBlockAssignment-r11 SEQUENCE{
	numberPRBPairs-r11 ENUMERATED {n2, n4, n8},
	resourceBlockAssignment-r11 BIT STRING (SIZE(4..38))
	},
	dmrs-ScramblingSequenceInt-r11 INTEGER (0..503),
	pucch-ResourceStartOffset-r11 INTEGER (0..2047),
	re-MappingQCLConfigListId-r11 PDSCH-RE-MappingQCL-ConfigId-r11 OPTIONAL -- Need OR
	}
	-- ASN1STOP
	epdcch-StartSymbol
	Indicates the OFDM starting symbol for any EPDCCH and PDSCH scheduled by EPDCCH on the same cell, if the UE is not configured with tm10. See TS 36.213 [23, 9.1.4.1]. If not present, the configuration is released and the UE shall derive the starting OFDM symbol of EPDCCH and PDSCH scheduled by EPDCCH from PCFICH. Values 1, 2, and 3 are only applicable for *dl-Bandwidth* greater than 10 resource blocks. Values 2, 3, and 4 are applicable otherwise. It is not configured for UEs configured with tm10.
	epdcch-SubframePatternConfig
	Configures the subframes which the UE shall monitor the UE-specific search space on EPDCCH. See TS 36.213 [23, 9.1.4]. If it is not configured when EPDCCH is configured, the UE monitors the UE-specific search space on EPDCCH in all subframes except for pre-defined rules in TS 36.213 [23, 9.1.4].
	resourceBlockAssignment
	Indicates the index to a specific combination of physical resource-block pair for EPDCCH set.
	
	numberPRBPairs
	Indicates the number of physical resource-block pairs used for the EPDCCH set. Value n2 corresponds to 2 physical resource-block pairs; n4 corresponds to 4 physical resource-block pairs and so on. n8 is not supported for *dl-Bandwidth* having value n6.	

c) transmitting, to said wireless device, second scheduling information on said second control	**Ref [2]** 6.3.2 Radio resource control information elements	Base station transmits scheduling information of PDSCH on the EPDCCH resource.

channel for a packet transmitted on said data channel.	– **EPDCCH-Config** ***epdcch-StartSymbol*** Indicates the OFDM starting symbol for any EPDCCH and PDSCH scheduled by EPDCCH on the same cell, if the UE is not configured with tm10. See TS 36.213 [23, 9.1.4.1]. **Ref [3]** **3.1 Definitions** **PDCCH:** Refers to the PDCCH [7], EPDCCH (in subframes when configured) or, for an RN with R-PDCCH configured and not suspended, to the R-PDCCH. **Ref [1]** **5 Physical Layer for E-UTRA** **Physical downlink control channel (PDCCH)** - Informs the UE and the RN about the resource allocation of PCH and DL-SCH, and Hybrid ARQ information related to DL-SCH; **Physical downlink shared channel (DL-)** - Carries the DL-SCH and PCH. **Ref [4]** **7.1 UE procedure for receiving the physical downlink shared channel** Except the subframes indicated by the higher layer parameter *mbsfn-SubframeConfigList*, a UE shall • upon detection of a PDCCH of a serving cell with DCI format 1, 1A, 1B, 1C, 1D, 2, 2A, 2B, 2C, or 2D intended for the UE in a subframe, or • upon detection of an EPDCCH of a serving cell with DCI format 1, 1A, 1B, 1D, 2, 2A, 2B, 2C, or 2D intended for the UE in a subframe decode the corresponding PDSCH in the same subframe with the restriction of the number of transport blocks defined in the higher layers.	Resource allocation information includes scheduling information. The scheduling information on EPDCCH is for a second packet communicated with the wireless device on PDSCH (DL-SCH).

References:

Ref [1]
3GPP TS 36.300 V11.4.0 (2012-12) (Release 11)

Technical Specification Group Radio Access Network;
Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN);
Overall description; Stage 2

Ref [2]
3GPP TS 36.331 V11.2.0 (2012-12) (Release 11)
Technical Specification Group Radio Access Network;
Evolved Universal Terrestrial Radio Access (E-UTRA);
Radio Resource Control (RRC); Protocol specification

Ref [3]
3GPP TS 36.321 v11.1.0 (2012-12) (Release 11)
Technical Specification Group Radio Access Network;
Evolved Universal Terrestrial Radio Access (E-UTRA);
Medium Access Control (MAC) protocol specification

Ref [4]
3GPP TS 36.213 V11.1.0 (2012-12) (Release 11)
Technical Specification Group Radio Access Network;
Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures

Illustrative Evidence of Use
U.S. Patent No. US 8,576,794
for R11 ePDCCH

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This Illustrative Evidence of Use chart is one of many example scenarios.

Patent no.: US 8,576,794

Title: Channel Configuration in a Wireless Network

Priority Date: June 28th, 2011

Status: issued

Number of Claims: 3 independent claims, 17 dependent claims

Summary: Claims are standard essential and are applicable to LTE Release-11 wireless devices and base stations.

Example Claim:

Claim 1: A method for use in a base station, the method comprising:

a) transmitting at least one message causing, in a wireless device, configuration of:

   i) first radio resources of a control channel, said first radio resources comprising one or more sets of resource blocks in a subset of subframes in a plurality of subframes, said at least one message indicating:

      (1) a starting OFDM symbol of said control channel in said subset of subframes; and

      (2) said subset of subframes in which said first radio resources of said control channel are configured;

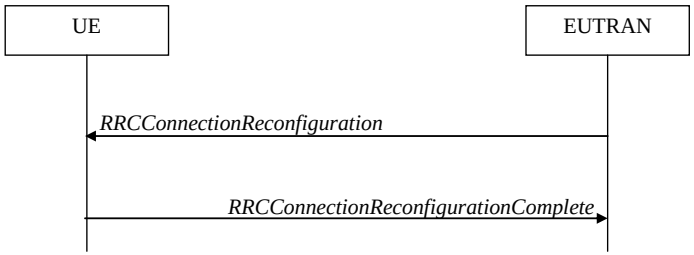
   ii) second radio resources of a HARQ channel to start from the first OFDM symbol of said plurality of subframes, said at least one message indicating a number of symbols in said second radio resources in each subframe in said plurality of subframes;

b) transmitting scheduling information on said control channel, said scheduling information being for a packet transmitted on an uplink channel;

c) receiving said packet on said uplink channel according to said scheduling information; and

d) transmitting a positive or negative acknowledgement on said second radio resources.

Claim 1	Standard/Product	Comments
A method for use in a base station, the method comprising:		The method applies to a Release-11 LTE base station.

a) transmitting at least one message causing, in a wireless device, configuration of:
 	
i) first radio resources of a control channel, said first radio resources comprising one or more sets of resource blocks in a subset of subframes in a plurality of subframes, said at least one message indicating:
 	
(1) a starting OFDM symbol of said control channel in said subset of subframes; and
 	
(2) said subset of subframes in which said first radio resources of said control channel are configured; and
	Ref [4]
	
	9.1.4 EPDCCH assignment procedure
	For each serving cell, higher layer signalling can configure a UE with one or two EPDCCH-PRB-sets for EPDCCH monitoring. The PRB-pairs corresponding to an EPDCCH-PRB-set are indicated by higher layers as described in section 9.1.4.4.
	
	Ref [2]
	
	5.3.5 RRC connection reconfiguration
	 
	
	Figure 5.3.5.1-1: RRC connection reconfiguration, successful
	
	6.3.2 Radio resource control information elements
	
	– EPDCCH-Config
	The IE EPDCCH-Config is used to configure the subframes and resource blocks for EPDCCH monitoring.
	
	EPDCCH-Config information element
	
	`EPDCCH-Config-r11 ::= SEQUENCE{`
	`  epdcch-SubframePatternConfig-r11 CHOICE {`
	`  release NULL,`
	`  setup SEQUENCE {`
	`  epdcch-SubframePattern-r11 MeasSubframePattern-r10`
	`  }`
	`  } OPTIONAL, -- Need ON`
		Base station transmits an RRC connection reconfiguration message. The RRC message causes configuration of EPDCCH (a control channel) and PDSCH (a data channel) in the wireless device.
		
		EPDCCH is configured for a subset of subframes.
		
		Radio resources of EPDCCH comprise one or more sets of RBs.
		
		EPDCCH starts from epdcch-StartSymbol symbol in the subset of subframes.

	epdcch-StartSymbol-r11 INTEGER (1..4) OPTIONAL, -- Need OP
	epdcch-SetConfigReleaseList-r11 EPDCCH-SetConfigReleaseList-r11 OPTIONAL, -- Need ON
	epdcch-SetConfigAddModList-r11 EPDCCH-SetConfigAddModList-r11 OPTIONAL -- Need ON
	}
	EPDCCH-SetConfig-r11 ::= SEQUENCE {
	epdcch-SetIdentity-r11 EPDCCH-SetIdentity-r11,
	epdcch-TransmissionType-r11 ENUMERATED {localised, distributed},
	epdcch-ResourceBlockAssignment-r11 SEQUENCE{
	numberPRBPairs-r11 ENUMERATED {n2, n4, n8},
	resourceBlockAssignment-r11 BIT STRING (SIZE(4..38))
	},
	dmrs-ScramblingSequenceInt-r11 INTEGER (0..503),
	pucch-ResourceStartOffset-r11 INTEGER (0..2047),
	re-MappingQCLConfigListId-r11 PDSCH-RE-MappingQCL-ConfigId-r11 OPTIONAL -- Need OR
	}
	-- ASN1STOP
	epdcch-StartSymbol
	Indicates the OFDM starting symbol for any EPDCCH and PDSCH scheduled by EPDCCH on the same cell, if the UE is not configured with tm10. See TS 36.213 [23, 9.1.4.1]. If not present, the configuration is released and the UE shall derive the starting OFDM symbol of EPDCCH and PDSCH scheduled by EPDCCH from PCFICH. Values 1, 2, and 3 are only applicable for *dl-Bandwidth* greater than 10 resource blocks. Values 2, 3, and 4 are applicable otherwise. It is not configured for UEs configured with tm10.
	epdcch-SubframePatternConfig
	Configures the subframes which the UE shall monitor the UE-specific search space on EPDCCH. See TS 36.213 [23, 9.1.4]. If it is not configured when EPDCCH is configured, the UE monitors the UE-specific search space on EPDCCH in all subframes except for pre-defined rules in TS 36.213 [23, 9.1.4].
	resourceBlockAssignment
	Indicates the index to a specific combination of physical resource-block pair for EPDCCH set.
	
	numberPRBPairs
	Indicates the number of physical resource-block pairs used for the EPDCCH set. Value n2 corresponds to 2 physical resource-block pairs; n4 corresponds to 4 physical resource-block pairs and so on. n8 is not supported for *dl-Bandwidth* having value n6.	

ii) second radio resources of a HARQ channel to start from the first OFDM	**Ref [2]** – **MasterInformationBlock** The *MasterInformationBlock* includes the system information transmitted on BCH.	At least one messages causes, in the UE, configuration of radio resources of PHICH to start

symbol of said plurality of subframes, said at least one message indicating a number of symbols in said second radio resources in each subframe in said plurality of subframes;	Signalling radio bearer: N/A
	
	RLC-SAP: TM
	
	Logical channel: BCCH
	
	Direction: E-UTRAN to UE
	
	MasterInformationBlock
	
	`-- ASN1START`
	
	`MasterInformationBlock ::= SEQUENCE {`
	`dl-Bandwidth ENUMERATED {`
	`n6, n15, n25, n50, n75, n100},`
	`phich-Config PHICH-Config,`
	`systemFrameNumber BIT STRING (SIZE (8)),`
	`spare BIT STRING (SIZE (10))`
	`}`
	
	`-- ASN1STOP`
	
	– **PHICH-Config**
	The IE *PHICH-Config* is used to specify the PHICH configuration.
	
	***PHICH-Config* information element**
	
	`-- ASN1START`
	
	`PHICH-Config ::= SEQUENCE {`
	`phich-Duration ENUMERATED {normal, extended},`
	`phich-Resource ENUMERATED {oneSixth, half, one, two}`
	`}`
	
	`-- ASN1STOP`
	
	phich-Duration
	Parameter: *PHICH-Duration*, see TS 36.211 [21, Table 6.9.3-1].
	
	Ref [5]
	The PHICH duration is configurable by higher layers according to Table 6.9.3-1.
		from the first OFDM symbols.
		
		Master information block in SIB1 (at least one message) is transmitted from eNB to UE and indicates the number of symbols of PHICH radio resources in each subframe. For example, for the case of Non-MBSFN FDD duration of PHICH can be 1 or 3 symbols.

	Table 6.9.3-1: PHICH duration in MBSFN and non-MBSFN subframes. **PHICH duration** | **Non-MBSFN subframes: Subframes 1 and 6 in case of frame structure type 2** | **Non-MBSFN subframes: All other cases** | **MBSFN subframes on a carrier supporting PDSCH** Normal | 1 | 1 | 1 Extended | 2 | 3 | 2	
b) transmitting scheduling information on said control channel, said scheduling information being for a packet transmitted on an uplink channel; c) receiving said packet on said uplink channel according to said scheduling information; and	**Ref [3]** **3.1 Definitions** **PDCCH:** Refers to the PDCCH [7], EPDCCH (in subframes when configured) or, for an RN with R-PDCCH configured and not suspended, to the R-PDCCH. **Ref [1]** **5 Physical Layer for E-UTRA** **Physical downlink control channel (PDCCH)** - Informs the UE and the RN about the resource allocation of PCH and DL-SCH, and Hybrid ARQ information related to DL-SCH; - Carries the uplink scheduling grant. **Ref [4]** **8.0 UE procedure for transmitting the physical uplink shared channel** For FDD and normal HARQ operation, the UE shall upon detection on a given serving cell of a PDCCH/EPDCCH with DCI format 0/4 and/or a PHICH transmission in subframe *n* intended for the UE, adjust the corresponding PUSCH transmission in subframe *n+4* according to the PDCCH/EPDCCH and PHICH information.	Base station transmits scheduling information on ePDCCH for transmission of packets on PUSCH. Upon detection of ePDCCH UE transmits a packet on PUSCH, which is received by the base station. The packet on PUSCH is received according to the scheduling information (uplink grant) transmitted on ePDCCH.
d) transmitting a positive or negative	**Ref [1]** **5 Physical Layer for E-UTRA** ...	Base station transmits positive or negative acknowledgements on PHICH in response to receiving the packet.

acknowledgement on said second radio resources.	**Physical Hybrid ARQ Indicator Channel (PHICH)** - Carries Hybrid ARQ ACK/NAKs in response to uplink transmissions.	

References:

Ref [1]
3GPP TS 36.300 V11.4.0 (2012-12) (Release 11)
Technical Specification Group Radio Access Network;
Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN);
Overall description; Stage 2

Ref [2]
3GPP TS 36.331 V11.2.0 (2012-12) (Release 11)
Technical Specification Group Radio Access Network;
Evolved Universal Terrestrial Radio Access (E-UTRA);
Radio Resource Control (RRC); Protocol specification

Ref [3]
3GPP TS 36.321 v11.1.0 (2012-12) (Release 11)
Technical Specification Group Radio Access Network;
Evolved Universal Terrestrial Radio Access (E-UTRA);
Medium Access Control (MAC) protocol specification

Ref [4]
3GPP TS 36.213 V11.1.0 (2012-12) (Release 11)
Technical Specification Group Radio Access Network;
Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures

Ref [5]
3GPP TS 36.211 V11.1.0 (2012-12)
Technical Specification Group Radio Access Network;
Evolved Universal Terrestrial Radio Access (E-UTRA);
Physical Channels and Modulation

Patent no.: US TBD – Notice of Allowance

Illustrative Evidence of Use
U.S. Patent No. US 8,427,976
for R13 NCT

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This Illustrative Evidence of Use chart is one of many example scenarios.

Patent no.: US 8,427,976

Title: Carrier Information Exchange between Base Stations

Priority Date: December 4, 2011

Status: Issued on April 23, 2013.

Number of Claims: 3 independent claims, 17 dependent claims

Summary: Claims are expected to become standard essential and are applicable to LTE Release-13 base stations.

Example Claim:

Claim 12. A method comprising:

a) receiving, by a first base station, a second application protocol message from a second base station, said second application protocol message comprising:

   i) a identifier of said second base station, said second base station comprising a plurality of carriers comprising:

      (1) at least one backward compatible carrier; and

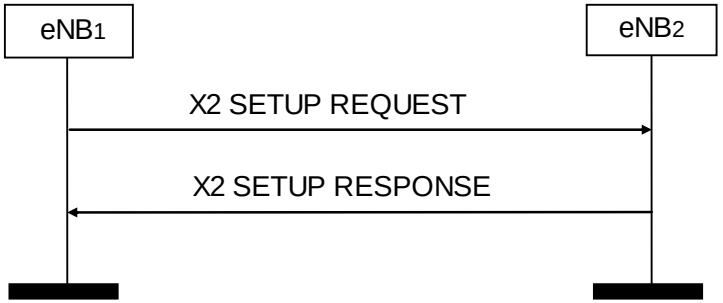
      (2) at least one non-backward compatible carrier, a first common reference signal overhead of each of said at least one non-backward compatible carrier being substantially lower than a second common reference signal overhead of each of said at least one backward compatible carrier;

   ii) at least one mobility management entity group identifier;

   iii) a cell identifier for each of said at least one backward compatible carrier; and

   iv) information identifying a carrier type for each of said plurality of carriers, said carrier type being one of at least a backward compatible type and a non-backward compatible type; and

b) operating, by said first base station, a wireless device handover based, at least in part, on information in said second application protocol message.

Claim 12	Standard/Product	Comments
A method comprising:		The method applies to a Release-13 LTE base station.
a) receiving, by a first base station, a second application protocol message from a second base station, said second application protocol message comprising:	**Ref [1]** **8.3.3 X2 Setup** ***8.3.3.1 General*** The purpose of the X2 Setup procedure is to exchange application level configuration data needed for two eNBs to interoperate correctly over the X2 interface. ***8.3.3.2 Successful Operation***  **Figure 8.3.3.2-1: X2 Setup, successful operation** An eNB_1 initiates the procedure by sending the X2 SETUP REQUEST message to a candidate eNB_2. The candidate eNB_2 replies with the X2 SETUP RESPONSE message. The initiating eNB_1 shall transfer the complete list of its served cells and, if available, a list of supported GU Group Ids to the candidate eNB_2. The candidate eNB_2 shall reply with the complete list of its served cells and shall include, if available, a list of supported GU Group Ids in the reply.	Either of X2 SETUP REQUEST or X2 SETUP RESPONSE messages are equivalent to "a second application protocol message." eNB1 and eNB2 exchange the SETUP message with each other.
i) an identifier of said second base station,	**Ref [1]**	SETUP message comprises a Global eNB ID (an

	9.1.2.3 X2 SETUP REQUEST This message is sent by an eNB to a neighbouring eNB to transfer the initialization information for a TNL association. Direction: eNB_1 → eNB_2. IE/Group Name: **Global eNB ID** Presence: M ***9.1.2.4 X2 SETUP RESPONSE*** This message is sent by an eNB to a neighbouring eNB to transfer the initialization information for a TNL association. Direction: eNB_2 → eNB_1. IE/Group Name: **Global eNB ID** Presence: M	identifier of said second base station).
said second base station comprising a plurality of carriers comprising: (1) at least one backward compatible carrier; and	**Ref [1]** ***9.1.2.3 X2 SETUP REQUEST*** This message is sent by an eNB to a neighbouring eNB to transfer the initialization information for a TNL association. Direction: eNB_1 → eNB_2. IE/Group Name: Served Cells Range: ***1 .. <maxCellineNB>*** **>**Served Cell Information Presence: M ***9.1.2.4 X2 SETUP RESPONSE*** This message is sent by an eNB to a neighbouring eNB to transfer the initialization information for a TNL association. Direction: eNB_2 → eNB_1. IE/Group Name: Served Cells	LTE release 10 and beyond supports carrier aggregation including a plurality of carriers. Release 11 PCell and SCell are backward compatible carriers. Each eNB must have a primary (backward compatible carrier).

	Range: ***1 .. <maxCellineNB>*** **>**Served Cell Information Presence: M **9.3.7 Constant definitions** `maxCellineNB INTEGER ::= 256` **Ref [2]** **7.5 Carrier Aggregation** When CA is configured, the UE only has one RRC connection with the network. At RRC connection establishment/re-establishment/handover, one serving cell provides the NAS mobility information (e.g. TAI), and at RRC connection re-establishment/handover, one serving cell provides the security input. This cell is referred to as the Primary Cell (PCell). In the downlink, the carrier corresponding to the PCell is the Downlink Primary Component Carrier (DL PCC) while in the uplink it is the Uplink Primary Component Carrier (UL PCC).	
(2) at least one non-backward compatible carrier, a first common reference signal overhead of each of said at least one non-backward compatible carrier being substantially lower than a second common reference signal overhead of each of said at least one backward compatible carrier;	**Ref [3]** **Title:** **Draft Report of 3GPP TSG RAN WG1 #71 v0.1.0 (New Orleans, USA, 12th - 16th November 2012)** **Document for:** **Comments** **Source:** **MCC Support** 6.3 LTE Release 12 6.3.1 New Carrier Type for LTE 6.3.1.1 PSS/SSS details 6.3.1.2 Synchronised new carriers	LTE release 13 may support non-backward compatible carriers. Non-backward compatible carriers are expected to operate with lower common reference signal overhead.

ii) at least one mobility management entity group identifier;	**Ref [1]** ***9.1.2.3 X2 SETUP REQUEST*** This message is sent by an eNB to a neighbouring eNB to transfer the initialization information for a TNL association. Direction: eNB_1 → eNB_2. IE/Group Name: GU Group Id List Range: ***0 .. <maxfPools>*** >>GU Group Id Presence: M ***9.1.2.4 X2 SETUP RESPONSE*** This message is sent by an eNB to a neighbouring eNB to transfer the initialization information for a TNL association. Direction: eNB_2 → eNB_1. IE/Group Name: GU Group Id List Range: ***0 .. <maxfPools>*** >>GU Group Id Presence: M **9.2.20 GU Group Id** The *GU Group Id* IE is the globally unique group id corresponding to a pool area. IE/Group Name: MME Group Id Presence: M **9.3.7 Constant definitions** `maxPools INTEGER ::= 16`	SETUP message comprises GU Group Id List. GU Group Id List comprises mobility management entity group identifier.
iii) a cell identifier for each of said at least one	**Ref [1]**	SETUP message comprises Served Cell Information.

backward compatible carrier; and	***9.1.2.3 X2 SETUP REQUEST*** This message is sent by an eNB to a neighbouring eNB to transfer the initialization information for a TNL association. Direction: eNB_1 → eNB_2. IE/Group Name: >Served Cell Information Presence: M ***9.1.2.4 X2 SETUP RESPONSE*** This message is sent by an eNB to a neighbouring eNB to transfer the initialization information for a TNL association. Direction: eNB_2 → eNB_1. IE/Group Name: >Served Cell Information Presence: M **9.2.8 Served Cell Information** This IE contains cell configuration information of a cell that a neighbour eNB may need for the X2 AP interface. IE/Group Name: Cell ID Presence: M IE type and reference: ECGI 9.2.14	Served Cell Information comprises Cell identifier.
iv) information identifying a carrier type for each of said plurality of carriers, said carrier type being one of at least a backward compatible type and a non-backward compatible type; and	**This limitation has not been included in the standard yet.**	It is expected that a carrier type field be added to the X2 message in LTE release 13 standard. The type field would identify carrier type (backward compatible and non-backward compatible).

		This information is usefull in improving handover decision performance.
b) operating, by said first base station, a wireless device handover based, at least in part, on information in said second application protocol message.	**Ref [1]** **8.3.3 X2 Setup** ***8.3.3.2 Successful Operation*** An eNB_1 initiates the procedure by sending the X2 SETUP REQUEST message to a candidate eNB_2. The candidate eNB_2 replies with the X2 SETUP RESPONSE message. The initiating eNB_1 shall transfer the complete list of its served cells and, if available, a list of supported GU Group Ids to the candidate eNB_2. The candidate eNB_2 shall reply with the complete list of its served cells and shall include, if available, a list of supported GU Group Ids in the reply. If a cell is switched off for energy savings reasons, it should be activated before initiating or responding to the X2 Setup procedure and shall still be included in the list of served cells. The initiating eNB_1 may include the *Neighbour Information* IE in the X2 SETUP REQUEST message. The candidate eNB_2 may also include the *Neighbour Information* IE in the X2 SETUP RESPONSE message. The *Neighbour Information* IE shall only include E-UTRAN cells that are direct neighbours of cells in the reporting eNB_2. A direct neighbour of one cell of eNB_2 may be any cell belonging to an eNB that is a neighbour of that eNB_2 cell e.g. even if the cell has not been reported by a UE. The initiating eNB1 may include the *TAC* IE with the *Neighbour Information* IE in the X2 SETUP REQUEST message. The candidate eNB2 may also include the *TAC* IE with the *Neighbour Information* IE in the X2 SETUP RESPONSE message. The eNB receiving the IE may use it according to TS 36.300 [15]. The initiating eNB_1 may include the *Number of Antenna Ports* IE in the X2 SETUP REQUEST message. The candidate eNB_2 may also include the *Number of Antenna Ports* IE in the X2 SETUP RESPONSE message. The eNB receiving the IE may use it according to TS 36.331 [9]. The initiating eNB_1 may include the *PRACH Configuration* IE in the X2 SETUP REQUEST message. The candidate eNB_2 may also include the *PRACH Configuration* IE in the X2 SETUP RESPONSE message. The eNB receiving the IE may use this information for RACH optimisation. The initiating eNB_1 may include the *MBSFN Subframe Info* IE in the X2 SETUP REQUEST message. The candidate eNB_2 may also include the *MBSFN Subframe Info* IE in the X2 SETUP RESPONSE message. The eNB receiving the IE may use it according to TS 36.331 [9].	The first base station operates a handover based, at least in part, on information highlighted in the SETUP message. At least the highlighted parameters are directly related to operating a handover process. For example, before initiating a handover the source eNB must check the GU Group IDs of the target base station and determine if the target base station is connected to the same eNB.

	For each CSG cell or hybrid cell served by the initiating eNB_1 the X2 SETUP REQUEST message shall contain the *CSG ID* IE. For each CSG cell or hybrid cell served by the candidate eNB_2 the X2 SETUP RESPONSE message shall contain the *CSG ID* IE. The eNB receiving the IE shall take this information into account when further deciding whether X2 handover between the source cell and the target cell may be performed. The initiating eNB1 may include the *MBMS Service Area Identity List* IE in the X2 SETUP REQUEST message. The candidate eNB2 may also include the *MBMS Service Area Identity List* IE in the X2 SETUP RESPONSE message. The eNB receiving the IE may use it according to TS 36.300 [15]. For each cell served by the initiating eNB1 the X2 SETUP REQUEST message may contain the *MultibandInfoList* IE. For cell served by the candidate eNB2 the X2 SETUP RESPONSE message may contain the *MultibandInfoList* IE. The eNB receiving the IE shall, if supported, take this information into account when further deciding whether subsequent mobility actions between the source cell and the target cell may be performed. **9.2.20 GU Group Id** The *GU Group Id* IE is the globally unique group id corresponding to a pool area. IE/Group Name: PLMN Id Presence: M IE/Group Name: MME Group Id Presence: M	

References:

Ref [1]
3GPP TS 36.423 V11.3.0 (2012-12) (Release 11)
Technical Specification Group Radio Access Network;
Evolved Universal Terrestrial Radio Access Network (E-UTRAN);
X2 application protocol (X2AP)

Ref [2]
3GPP TS 36.300 V11.4.0 (2012-12) (Release 11)

Technical Specification Group Radio Access Network;
Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN);
Overall description; Stage 2

Ref [3]
3GPP.org
Home » Specification Groups » RAN Plenary » RAN1 - Radio layer 1
http://www.3gpp.org/RAN1-Radio-layer-1
RAN1 Report is stored at at: http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_71/Report/

Illustrative Evidence of Use
EP Patent No. EP 2564612 A1
for ePDCCH

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This Illustrative Evidence of Use chart is one of many example scenarios.

EP Patent Application no.: EP20120741415.9, Publication no.: EP2564612 A1

Title: Broadcast Channel in Multicarrier Systems

Priority Date: July 4th, 2011

Status: Allowed

Number of Claims: 2 independent claims, 13 dependent claims

Summary: Claims are expected to become standard essential and are applicable to LTE Release-11 wireless devices and base stations.

Example Claim:

Claim 1: A method comprising:

a) transmitting downlink control information on a first control channel by a base station, said downlink control information:

   i) providing first transmission format and first scheduling information for a first plurality of data packets transmitted on a first data channel of a first carrier in a plurality of carriers; and

   ii) transmitted on said first carrier starting from the first OFDM symbol in a plurality of OFDM symbols of a first subframe in a plurality of subframes;

b) transmitting said first plurality of data packets by said base station on said first data channel, transmission of said first plurality of data packets starting from an OFDM symbol subsequent to said plurality of OFDM symbols employed for transmission of said downlink control information;

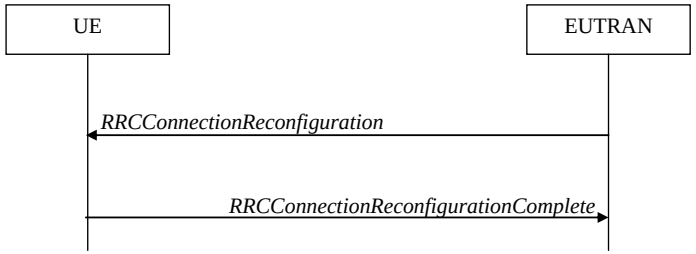
c) transmitting at least one control message by said base station on said first data channel to a wireless device, said at least one control message configured to cause configuration of first radio resources of a second data channel and second radio resources of a second control channel of a second carrier in said plurality of carriers, said second control channel providing second scheduling information for said second data channel, said at least one control message indicating configuration of a subset of subframes in which said second radio resources of said second control channel are configured; and

d) transmitting a second plurality of data packets by said base station to said wireless device on said second data channel.

Claim 1	Standard/Product	Comments
A method comprising:		The method applies to a Release-11 LTE base station.
a) transmitting downlink control information on a first control channel by a base station, said downlink control information: i) providing first transmission format and first scheduling information for a first plurality of data packets transmitted on a first data channel of a first carrier in a plurality of carriers; and ii) transmitted on said first carrier starting from the first OFDM symbol in a plurality of OFDM symbols of a first subframe in a plurality of subframes;	**Ref [3]** **5 Physical Layer for E-UTRA** **Physical downlink control channel (PDCCH)** - Informs the UE and the RN about the resource allocation of PCH and DL-SCH, and Hybrid ARQ information related to DL-SCH; **5.1.3 Physical downlink control channel** The downlink control signalling (PDCCH) is located in the first *n* OFDM symbols where $n \leq 4$ and consists of: - Transport format and resource allocation related to DL-SCH and PCH, and hybrid ARQ information related to DL-SCH;	The base station transmits the downlink control information on the first subframe of the first carrier on PDCCH channel. The downlink control information includes transport format (transmission format) and resource allocation (scheduling information) for first data packets transmitted on PDSCH of the first carrier. The downlink control information is transmitted on the first *n* OFDM symbol (starting from the first OFDM symbol) of the first subframe.
b) transmitting said first plurality of data packets by said base station on	**Ref [3]** **5 Physical Layer for E-UTRA** **Physical downlink shared channel (PDSCH)**	Base station transmits first data packets on the first data channel (PDSCH).

said first data channel, transmission of said first plurality of data packets starting from an OFDM symbol subsequent to said plurality of OFDM symbols employed for transmission of said downlink control information;	- Carries the DL-SCH and PCH. **Ref [2]** *7.1.6.4 PDSCH starting position* The starting OFDM symbol for the PDSCH of each activated serving cell given by index $l_{DataStart}$ in the first slot in a subframe. For a UE configured in transmission mode 1-9, for a given activated serving cell – if the PDSCH is assigned by EPDCCH received in the same serving cell, or if the UE is configured to monitor EPDCCH in the subframe and the PDSCH is not assigned by a PDCCH/EPDCCH, and if the UE is configured with the higher layer parameter *epdcch-StartSymbol-r11* ▪ $l_{DataStart}$ is given by the higher-layer parameter *epdcch-StartSymbol-r11*. – else if the UE is configured with carrier indicator field for the given serving cell and if PDSCH and the corresponding PDCCH/EPDCCH are received on different serving cells ○ $l_{DataStart}$ is given by the higher-layer parameter *pdsch-Start* for the serving cell on which PDSCH is received if the UE is configured with carrier indicator field for the given serving cell and if PDSCH and the corresponding PDCCH/EPDCCH are received on different serving cells, – Otherwise ○ $l_{DataStart}$ is given by the span of the DCI given by the CFI value in the subframe of the given serving cell according to Section 5.3.4 of [4] otherwise. For a UE configured in transmission mode 10, for a given activated serving cell – if the PDSCH is assigned by a PDCCH with DCI format 1C or by a PDCCH with DCI format 1A and with CRC scrambled with P-RNTI/RA-RNTI/SI-RNTI/Temporary C-RNTI ○ $l_{DataStart}$ is given by the CFI value in the subframe of the given serving cell. – if the PDSCH is assigned by a PDCCH/EPDCCH with DCI format 1A and with CRC scrambled with C-RNTI/SPS C-RNTI	In a scenario considered here, the first carrier can be the Primary carrier (PCell). Transmission of the first data packets starts from the symbol *DataStart* which is given by CFI (Control Format Indicator). CFI determines the size of PDCCH. Therefore, DL-SCH of the first carrier starts from an OFDM symbol subsequent to PDCCH. Symbols in a subframe are numbered starting from symbol number 0.

	○ if the value of the 'PDSCH starting position for PDSCH RE mapping' determined from the higher-layer parameter re-MappingQCLConfigListId associated with DCI format 1A (according to Section 7.1.9) for the serving cell on which PDSCH is received is 5, ▪ if the UE is configured with carrier indicator field for the given serving cell and if PDSCH and the corresponding PDCCH/EPDCCH are received on different serving cells, • $l'_{DataStart}$ is given by the higher-layer parameter pdsch-Start for the serving cell on which PDSCH is received ▪ otherwise • $l'_{DataStart}$ is given by the CFI value in the subframe of the given serving cell. ○ else ▪ $l'_{DataStart}$ is the value of the 'PDSCH starting position for PDSCH RE mapping' determined from the higher-layer parameter re-MappingQCLConfigListId associated with DCI format 1A (according to Section 7.1.9) for the serving cell on which PDSCH is received. ○ if the subframe is indicated by the 'MBSFN subframe configuration for PDSCH RE mapping' determined from the higher-layer parameter re-MappingQCLConfigListId associated with DCI format 1A (according to Section 7.1.9) for the serving cell on which PDSCH is received, ▪ $l_{DataStart} = \min(2, l'_{DataStart})$, ○ otherwise ▪ $l_{DataStart} = l'_{DataStart}$. – if the PDSCH is assigned by a PDCCH/EPDCCH with DCI format 2D, – if the value of the 'PDSCH starting position for PDSCH RE mapping' determined from the DCI (according to Section 7.1.9) for the serving cell on which PDSCH is received is 5,	

	○ if the UE is configured with carrier indicator field for the given serving cell and if PDSCH and the corresponding PDCCH/EPDCCH are received on different serving cells, ▪ $l'_{DataStart}$ is given by the higher-layer parameter *pdsch-Start* for the serving cell on which PDSCH is received ○ Otherwise ▪ $l'_{DataStart}$ is given by the CFI value in the subframe of the given serving cell.	
c) transmitting at least one control message by said base station on said first data channel to a wireless device, said at least one control message configured to cause configuration of first radio resources of a second data channel and second radio resources of a second control channel of a second carrier in said plurality of carriers, said second control channel providing second scheduling information for said second data channel, said at least one control message indicating configuration of a subset of subframes in which said second radio resources of said second	**Ref [1]** **9.1.4 EPDCCH assignment procedure** For each serving cell, higher layer signalling can configure a UE with one or two EPDCCH-PRB-sets for EPDCCH monitoring. The PRB-pairs corresponding to an EPDCCH-PRB-set are indicated by higher layers as described in section 9.1.4.4. **Ref [4]** **5.3.5 RRC connection reconfiguration**  **Figure 5.3.5.1-1: RRC connection reconfiguration, successful** The purpose of this procedure is to modify an RRC connection, e.g. to establish/ modify/ release RBs, to perform handover, to setup/ modify/ release measurements, to add/ modify/ release SCells. As part of the procedure, NAS dedicated information may be transferred from E-UTRAN to the UE. 6.3.2 Radio resource control information elements	Base station transmits an RRC connection reconfiguration message. The RRC message causes configuration of EPDCCH (a control channel) and PDSCH (a data channel) in the wireless device compatible with release 11 or higher. EPDCCH is configured for a subset of subframes. RRC message indicates the subset of subframes using SubframePattern bitmap. Radio resources of EPDCCH comprise multiple sets of RBs. There could be up to two different sets of EPDCCH radio resources, each comprising many resource blocks. Base station transmits scheduling information of PDSCH on the EPDCCH resource.

control channel are configured; and

- **EPDCCH-Config**

The IE EPDCCH-Config is used to configure the subframes and resource blocks for EPDCCH monitoring.

EPDCCH-Config information element

```
EPDCCH-Config-r11 ::=       SEQUENCE{
    epdcch-SubframePatternConfig-r11    CHOICE {
        release                             NULL,
        setup                               SEQUENCE {
            epdcch-SubframePattern-r11      MeasSubframePattern-r10
        }
    }                                                                   OPTIONAL, -- Need
ON
    epdcch-StartSymbol-r11              INTEGER (1..4)                  OPTIONAL, -- Need
OP
    epdcch-SetConfigReleaseList-r11     EPDCCH-SetConfigReleaseList-r11     OPTIONAL, -- Need
ON
    epdcch-SetConfigAddModList-r11      EPDCCH-SetConfigAddModList-r11      OPTIONAL -- Need ON
}
EPDCCH-SetConfig-r11 ::=    SEQUENCE {
    epdcch-SetIdentity-r11              EPDCCH-SetIdentity-r11,
    epdcch-TransmissionType-r11         ENUMERATED {localised, distributed},
    epdcch-ResourceBlockAssignment-r11  SEQUENCE{
        numberPRBPairs-r11                  ENUMERATED {n2, n4, n8},
        resourceBlockAssignment-r11         BIT STRING (SIZE(4..38))
    },
    dmrs-ScramblingSequenceInt-r11      INTEGER (0..503),
    pucch-ResourceStartOffset-r11       INTEGER (0..2047),
    re-MappingQCLConfigListId-r11       PDSCH-RE-MappingQCL-ConfigId-r11    OPTIONAL -- Need OR
}
-- ASN1STOP
```

epdcch-SubframePatternConfig
Configures the subframes which the UE shall monitor the UE-specific search space on EPDCCH. See TS 36.213 [23, 9.1.4]. If it is not configured when EPDCCH is configured, the UE monitors the UE-specific search space on EPDCCH in all subframes except for pre-defined rules in TS 36.213 [23, 9.1.4].
resourceBlockAssignment
Indicates the index to a specific combination of physical resource-block pair for EPDCCH set.

numberPRBPairs
Indicates the number of physical resource-block pairs used for the EPDCCH set. Value n2 corresponds to 2 physical resource-block pairs; n4 corresponds to 4 physical resource-block pairs and so on. n8 is not supported for *dl-Bandwidth* having value n6.

Ref [1]

	7.1 UE procedure for receiving the physical downlink shared channel Except the subframes indicated by the higher layer parameter *mbsfn-SubframeConfigList*, a UE shall • upon detection of a PDCCH of a serving cell with DCI format 1, 1A, 1B, 1C, 1D, 2, 2A, 2B, 2C, or 2D intended for the UE in a subframe, or • upon detection of an EPDCCH of a serving cell with DCI format 1, 1A, 1B, 1D, 2, 2A, 2B, 2C, or 2D intended for the UE in a subframe decode the corresponding PDSCH in the same subframe with the restriction of the number of transport blocks defined in the higher layers.	
d) transmitting a second plurality of data packets by said base station to said wireless device on said second data channel.	**Ref [3]** **5 Physical Layer for E-UTRA** **Physical downlink shared channel (DL-)** - Carries the DL-SCH and PCH.	Base station transmits second data packets to the wireless device on the second data channel (PDSCH).

References:

Ref [1]
3GPP TS 36.213 V11.1.0 (2012-12) (Release 11)
Technical Specification Group Radio Access Network;
Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures

Ref [2]
3GPP TS 36.213 V11.1.0 (2012-12) (Release 11)
Technical Specification Group Radio Access Network;
Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures

Ref [3]
3GPP TS 36.300 V11.4.0 (2012-12) (Release 11)
Technical Specification Group Radio Access Network;
Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN);
Overall description; Stage 2

Ref [4]

3GPP TS 36.331 V11.2.0 (2012-12) (Release 11)
Technical Specification Group Radio Access Network;
Evolved Universal Terrestrial Radio Access (E-UTRA);
Radio Resource Control (RRC); Protocol specification