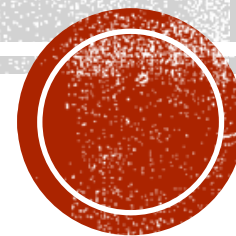
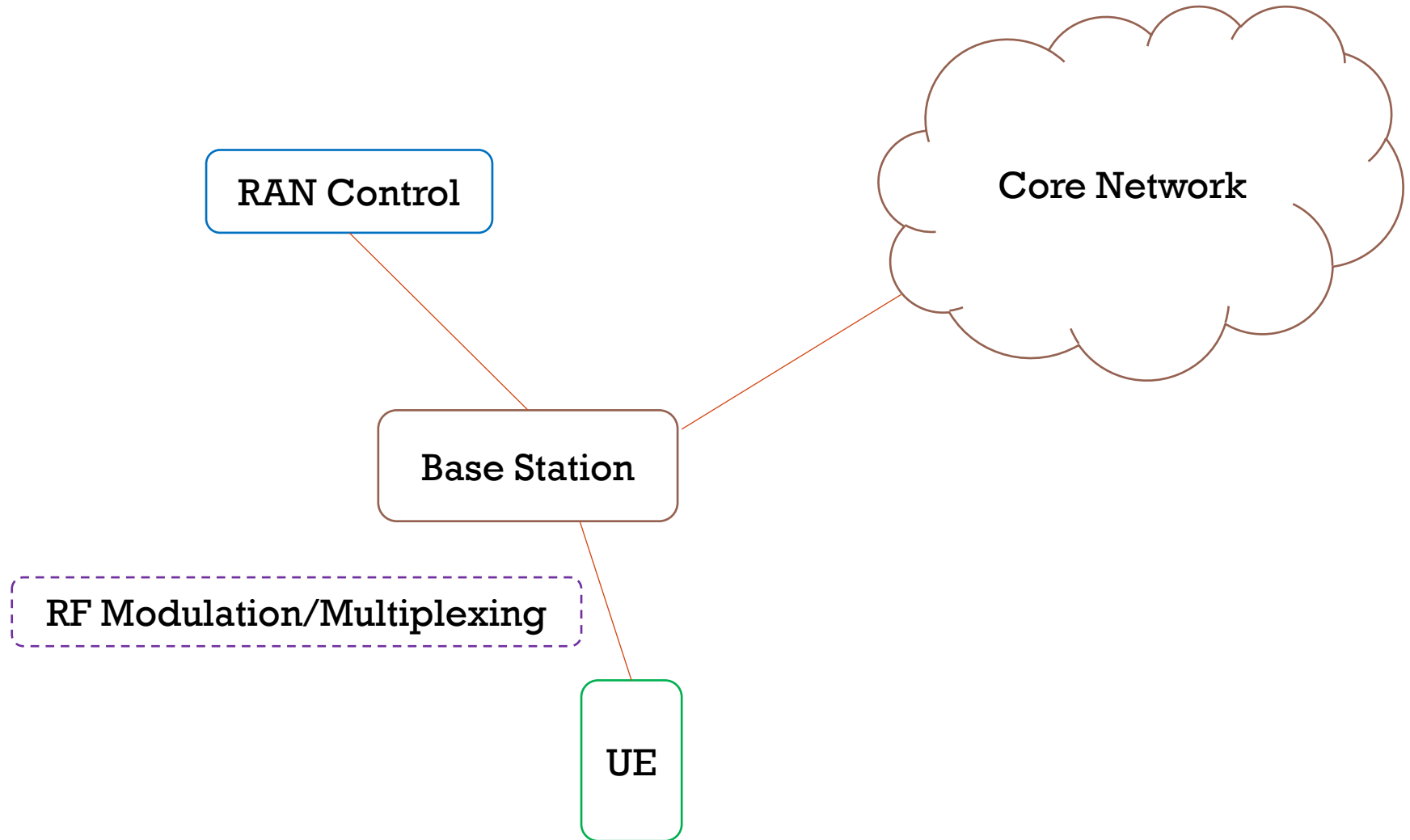


無線接取網路三

cory@gms.tku.edu.tw



Recall



Outlines

- O-RAN E2 詳解
- UE連接過程



為什麼選E2來解釋

- 可以呈現RAN管理所需的要素
- 定義方式、架構與3GPP多數control plane協定類似
- 較為精簡、易懂



E2AP Class 1 Procedures

Initiated by	Elementary Procedure	Initiating Message	Successful Outcome	Unsuccessful Outcome
			Response message	Response message
Near-RT RIC	RIC Subscription	RIC SUBSCRIPTION REQUEST	RIC SUBSCRIPTION RESPONSE	RIC SUBSCRIPTION FAILURE
Near-RT RIC	RIC Subscription Delete	RIC SUBSCRIPTION DELETE REQUEST	RIC SUBSCRIPTION DELETE RESPONSE	RIC SUBSCRIPTION DELETE FAILURE
E2 Node	RIC Service Update	RIC SERVICE UPDATE	RIC SERVICE UPDATE ACKNOWLEDGE	RIC SERVICE UPDATE FAILURE
Near-RT RIC	RIC Control	RIC CONTROL REQUEST	RIC CONTROL ACKNOWLEDGE	RIC CONTROL FAILURE
E2 Node	E2 Setup	E2 SETUP REQUEST	E2 SETUP RESPONSE	E2 SETUP FAILURE
E2 Node	E2 Node Configuration Update	E2 NODE CONFIGURATION UPDATE	E2 NODE CONFIGURATION UPDATE ACKNOWLEDGE	E2 NODE CONFIGURATION UPDATE FAILURE
Near-RT RIC	E2 Connection Update	E2 CONNECTION UPDATE	E2 CONNECTION UPDATE ACKNOWLEDGE	E2 CONNECTION UPDATE FAILURE
Near-RT RIC or E2 Node	Reset	RESET REQUEST	RESET RESPONSE	



E2AP Class 2 Procedures

Initiated by	Elementary Procedure	Initiating Message
E2 Node	RIC Indication	RIC INDICATION
Near-RT RIC	RIC Service Query	RIC SERVICE QUERY
E2 Node or Near-RT RIC	Error Indication	ERROR INDICATION



E2 Setup Request

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.3		YES	reject
Global E2 Node ID	M		9.2.6		YES	reject
List of RAN Functions Added		0 .. <maxofRANfunctionID>			YES	reject
>RAN Function ID	M		9.2.8	Id of the declared Function	-	
>RAN Function Definition	M		9.2.23	Definition of Function	-	
>RAN Function Revision	M		9.2.24	Revision counter		
>RAN Function OID	O		9.2.31	Object identifier of corresponding E2SM		
E2 Node Component Configuration Update List		0..1			YES	reject
>E2 Node Component Configuration Update Item		1.. <maxofE2nodeComponents>			EACH	reject
>>E2 Node Component Type	M		9.2.26	E2 Node component type	-	
>>E2 Node Component ID	O		9.2.32	E2 Node Component Identifier	-	
>>E2 Node Component Configuration Update	M		9.2.27	Contents depends on component type	-	

Range bound	Explanation
maxofRANfunctionID	Maximum no. of RAN Functions supported by E2 Node. Value is 256.
maxofE2nodeComponents	Maximum no. of E2 Node components supported by E2 Node. Value is 1024



E2 Setup Request (Related ASN.1)

```
E2setupRequest ::= SEQUENCE {
    protocolIEs      ProtocolIE-Container          { {E2setupRequestIEs} },
    ...
}

E2setupRequestIEs E2AP-PROTOCOL-IES ::= {
    { ID id-TransactionID          CRITICALITY reject  TYPE TransactionID
      PRESENCE mandatory }|
    { ID id-Globale2node-ID        CRITICALITY reject  TYPE Globale2node-ID
      PRESENCE mandatory }|
    { ID id-RANfunctionsAdded      CRITICALITY reject  TYPE RANfunctions-List
      PRESENCE mandatory }|
    { ID id-E2nodeComponentConfigAddition CRITICALITY reject  TYPE E2nodeComponentConfigAddition-
      List      PRESENCE mandatory },
    ...
}
```



E2 Setup Response

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.3		YES	reject
Global RIC ID	M		9.2.4		YES	reject
List of RAN Functions Accepted		0 .. <maxofRANfunctionID>		Complete list of Functions accepted by Near-RT RIC	YES	Reject
>RAN Function ID	M		9.2.8	Id of the declared Function	-	
List of RAN Functions Rejected		0 .. <maxofRANfunctionID>		Complete list of Functions not accepted by Near-RT RIC	YES	reject
>RAN Function ID	M		9.2.8	Id of the declared Function		
>Cause	M		9.2.1	Reason for not accepting function		
E2 Node Component Configuration Update Acknowledge List		0 .. <maxofE2nodeComponents>		Complete list of E2 Node Components in the E2 SETUP REQUEST message	YES	reject
>E2 Node Component Configuration Update Acknowledge Item					EACH	reject
>>E2 Node Component Type	M		9.2.26	E2 Node component type	-	
>>E2 Node Component ID	O		9.2.32	E2 Node Component Identifier	-	
>>E2 Node Component Configuration Update Acknowledge	M		9.2.28	Success or failure with Cause	-	

Range bound	Explanation
maxofRANfunctionID	Maximum no. of RAN Functions supported by E2 Node. Value is 256.
maxofE2nodeComponents	Maximum no. of E2 Node components supported by E2 Node. Value is 1024



E2 Setup Failure

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.3		YES	reject
Cause	M		9.2.1		YES	ignore
Time To Wait	O		9.2.5		YES	ignore
Criticality Diagnostics	O		9.2.2		YES	Ignore
Transport Layer Information	O		9.2.29		YES	ignore



Message Type

IE/Group Name	Presence	Range	IE type and reference	Semantics description
Message Type				
>Procedure Code	M		INTEGER (0..255)	
>Type of Message	M		CHOICE (Initiating Message, Successful Outcome, Unsuccessful Outcome, ...)	



E2 Node Parameters

9.2.6 Global E2 Node ID

This IE is used to globally identify an E2 node.

IE/Group Name	Presence	Range	IE type and reference	Semantics description
CHOICE <i>Global E2 Node</i>	M			
> <i>gNB</i>				
>>Global gNB ID	M		3GPP 38.423 clause 9.2.2.1	
>>gNB-CU-UP ID	O		3GPP 38.463 clause 9.3.1.15	
>>gNB-DU ID	O		3GPP 38.473 clause 9.3.1.9	
> <i>en-gNB</i>				
>>Global en-gNB ID			3GPP 36.423 clause 9.2.112	
> <i>ng-eNB</i>				
>>Global ng-eNB ID	M		3GPP 38.423 clause 9.2.2.2	
> <i>eNB</i>				
>>Global eNB ID	M		3GPP 36.423 clause 9.2.22	

9.2.26 E2 Node Component Type

This IE is used to identify an E2 node component type.

IE/Group Name	Presence	Range	IE type and reference	Semantics description
E2 node component type	M		ENUMERATED (gNB, gNB-CU-UP, gNB-DU, en-gNB, eNB, ng-eNB, ...)	



E2 Node Component Parameters

9.2.27 E2 Node Component Configuration Update

This IE is used to carry the E2 Node component configuration update information of a specific E2 Node component. In all cases the information is a data structure defined by the appropriate 3GPP specification and carried as an OCTET STRING.

IE/Group Name	Presence	Range	IE type and reference	Semantics description
CHOICE <i>E2 node component type</i>	M			
>gNB				
>>NGAP gNB-CU-CP configuration update	O		OCTET STRING	Content defined by 3GPP 38.413 clause 9.2.6.4
>>XnAP gNB CU-CP configuration update	O		OCTET STRING	Content defined by 3GPP 38.423 clause 9.1.3.4
>>E1AP gNB-CU-UP configuration update	O		OCTET STRING	Content defined by 3GPP 38.463 clause 9.2.1.10
>>F1AP gNB-DU configuration update	O		OCTET STRING	Content defined by 3GPP 38.473 clause 9.2.1.7
>en-gNB				
>>X2AP en-gNB configuration update	O		OCTET STRING	Content defined by 3GPP 36.423 clause 9.1.2.8
>ng-eNB				
>>NGAP ng-eNB configuration update	O		OCTET STRING	Content defined by 3GPP 38.413 clause 9.2.6.4
>>XnAP ng-eNB configuration update	O		OCTET STRING	Content defined by 3GPP 38.423 clause 9.1.3.4
>eNB				
>>S1AP eNB configuration update	O		OCTET STRING	Content defined by 3GPP 36.413 clause 9.1.8.7
>>X2AP eNB config update	O		OCTET STRING	Content defined by 3GPP 36.423 clause 9.1.2.8

9.2.32 E2 Node Component ID

This IE is used to locally identify an E2 node component.

IE/Group Name	Presence	Range	IE type and reference	Semantics description
CHOICE <i>E2 node component type</i>	M			
>gNB-CU-UP				
>>gNB-CU-UP ID	M		3GPP 38.463 clause 9.3.1.15	
>gNB-DU				
>>gNB-DU ID	M		3GPP 38.473 clause 9.3.1.9	



E2 Node Related ASN.1

```
Globale2node-ID ::= CHOICE{
    gNB                Globale2node-gNB-ID,
    en-gNB             Globale2node-en-gNB-ID,
    ng-eNB             Globale2node-ng-eNB-ID,
    eNB                Globale2node-eNB-ID,
    ...
}

Globale2node-en-gNB-ID ::= SEQUENCE{
    global-en-gNB-ID    GlobalenGNB-ID,
    en-gNB-CU-UP-ID    GNB-CU-UP-ID    OPTIONAL,
    en-gNB-DU-ID       GNB-DU-ID       OPTIONAL,
    ...
}

Globale2node-eNB-ID ::= SEQUENCE{
    global-eNB-ID       GlobalENB-ID,
    ...
}

Globale2node-gNB-ID ::= SEQUENCE{
    global-gNB-ID       GlobalgNB-ID,
    global-en-gNB-ID    GlobalenGNB-ID    OPTIONAL,
    gNB-CU-UP-ID        GNB-CU-UP-ID    OPTIONAL,
    gNB-DU-ID           GNB-DU-ID        OPTIONAL,
    ...
}

Globale2node-ng-eNB-ID ::= SEQUENCE{
    global-ng-eNB-ID    GlobalngenNB-ID,
    global-eNB-ID       GlobalENB-ID    OPTIONAL,
    ngENB-DU-ID         NGENB-DU-ID     OPTIONAL,
    ...
}
```

```
GlobalgNB-ID ::= SEQUENCE {
    plmn-id          PLMN-Identity,
    gnb-id           GNB-ID-Choice,
    ...
}
```

```
PLMN-Identity ::= OCTET STRING (SIZE(3))
```

```
GNB-ID-Choice ::= CHOICE {
    gnb-ID          BIT STRING (SIZE(22..32)),
    ...
}
```



RAN Function Parameters

9.2.8 RAN Function ID

This information element indicates the RAN Function ID number, to be unique within a given E2 Node.

IE/Group Name	Presence	Range	IE type and reference	Semantics description
RAN Function ID	M		INTEGER (0..4095)	Value 0 reserved for Near-RT RIC internal usage

9.2.23 RAN Function Definition

This information element carries the RAN Function Definition.

IE/Group Name	Presence	Range	IE type and reference	Semantics description
RAN Function Definition	M		OCTET STRING	Defined in RAN Function specific E2 Service Model [3]

9.2.24 RAN Function Revision

This information element carries the RAN Function Revision.

IE/Group Name	Presence	Range	IE type and reference	Semantics description
RAN Function Revision	M		INTEGER (0..4095)	

9.2.31 RAN Function OID

This information element carries the RAN Function OID

IE/Group Name	Presence	Range	IE type and reference	Semantics description
RAN Function Service Model OID	M		PrintableString(SIZE(1..1000,...))	Object Identifier of the specific RAN Function definition. Formatted as per OID (e.g. 1.3.6.1.4.1.53148.1.2.1 for E2SM-NI)



RAN Function Related ASN.1

```
RANfunctions-List ::= SEQUENCE (SIZE(1..maxofRANfunctionID)) OF ProtocolIE-SingleContainer {
{RANfunction-ItemIEs} }

RANfunction-ItemIEs E2AP-PROTOCOL-IES ::= {
  { ID id-RANfunction-Item          CRITICALITY ignore  TYPE RANfunction-Item
    PRESENCE mandatory },
  ...
}

RANfunction-Item ::= SEQUENCE {
  ranFunctionID          RANfunctionID,
  ranFunctionDefinition  RANfunctionDefinition,
  ranFunctionRevision    RANfunctionRevision,
  ranFunctionOID         RANfunctionOID,
  ...
}
```

```
RANfunctionDefinition ::= OCTET STRING

RANfunctionID ::= INTEGER (0..4095)

RANfunctionOID ::= PrintableString(SIZE(1..1000,...))

RANfunctionRevision ::= INTEGER (0..4095)
```

```
RANfunctionsID-List ::= SEQUENCE (SIZE(1..maxofRANfunctionID)) OF ProtocolIE-
SingleContainer{{RANfunctionID-ItemIEs}}

RANfunctionID-ItemIEs E2AP-PROTOCOL-IES ::= {
  { ID id-RANfunctionID-Item          CRITICALITY ignore      TYPE RANfunctionID-Item
    PRESENCE mandatory },
  ...
}

RANfunctionID-Item ::= SEQUENCE {
  ranFunctionID          RANfunctionID,
  ranFunctionRevision    RANfunctionRevision,
  ...
}
```



RIC Subscription Request

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.3		YES	reject
RIC Request ID	M		9.2.7		YES	reject
RAN Function ID	M		9.2.8		YES	reject
RIC Subscription Details	M				YES	reject
>RIC Event Trigger Definition	M		9.2.9		-	
>Sequence of Actions		1.. <maxofRICactionID>			EACH	ignore
>>RIC Action ID	M		9.2.10		-	
>>RIC Action Type	M		9.2.11		-	
>>RIC Action Definition	O		9.2.12			
>>RIC Subsequent Action	O		9.2.13			

IE/Group Name	Presence	Range	IE type and reference	Semantics description
RIC Requestor ID	M		INTEGER (0..65535)	
RIC Instance ID	M		INTEGER (0..65535)	

Range bound	Explanation
maxofRICactionID	Maximum no. of Actions to be requested by Near-RT RIC. Value is 16.



RIC Subscription Response

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.3		YES	reject
RIC Request ID	M		9.2.7		YES	reject
RAN Function ID	M		9.2.8		YES	reject
RIC Actions Admitted List		1.. <maxofRICactionID>			YES	reject
>RIC Action ID	M		9.2.10		-	
RIC Actions Not Admitted List		0.. <maxofRICactionID>			YES	reject
>RIC Action ID	M		9.2.10		-	
>Cause	M		9.2.1		-	

Range bound	Explanation
maxofRICactionID	Maximum no. of Actions to be requested by Near-RT RIC. Value is 16.



RIC Subscription Failure

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.3		YES	reject
RIC Request ID	M		9.2.7		YES	reject
RAN Function ID	M		9.2.8		YES	reject
RIC Actions Not Admitted List		1.. <maxofRICactionID>			YES	reject
>RIC Action ID	M		9.2.10		-	
>Cause	M		9.2.1		-	
Criticality Diagnostics	O		9.2.2		YES	ignore

Range bound	Explanation
maxofRICActionID	Maximum no. of Actions to be requested by Near-RT RIC. Value is 16.



RIC Indication

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.3		YES	reject
RIC Request ID	M		9.2.7		YES	reject
RAN Function ID	M		9.2.8		YES	reject
RIC Action ID	M		9.2.10		YES	reject
RIC Indication SN	O		9.2.14		YES	reject
RIC Indication Type	M		9.2.15		YES	reject
RIC Indication Header	M		9.2.17		YES	reject
RIC Indication Message	M		9.2.16		YES	reject
RIC Call process ID	O		9.2.18		YES	reject

IE/Group Name	Presence	Range	IE type and reference	Semantics description
RIC Indication Type	M		ENUMERATED (Insert, Report, ...)	

IE/Group Name	Presence	Range	IE type and reference	Semantics description
RIC Indication header	M		OCTET STRING	Defined in RAN Function specific E2 Service Model [3]

IE/Group Name	Presence	Range	IE type and reference	Semantics description
RIC Indication message	M		OCTET STRING	Defined in RAN Function specific E2 Service Model [3]



RIC Control Request

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.3		YES	reject
RIC Request ID	M		9.2.7		YES	reject
RAN Function ID	M		9.2.8		YES	reject
RIC Call Process ID	O		9.2.18		YES	reject
RIC Control Header	M		9.2.20		YES	reject
RIC Control Message	M		9.2.19		YES	reject
RIC Control Ack Request	O		9.2.21		YES	reject

IE/Group Name	Presence	Range	IE type and reference	Semantics description
RIC Control header	M		OCTET STRING	Defined in RAN Function specific E2 Service Model [3]

IE/Group Name	Presence	Range	IE type and reference	Semantics description
RIC Control Message	M		OCTET STRING	Defined in RAN Function specific E2 Service model [3]

IE/Group Name	Presence	Range	IE type and reference	Semantics description
RIC Control Ack Request	M		ENUMERATED (NoAck, Ack, NAck, ...)	



Cause

IE/Group Name	Presence	Range	IE Type and Reference	Semantics Description
CHOICE Cause Group	M			
>RIC services				
>>RIC Request	O		ENUMERATED (RAN Function ID Invalid, Action not supported, Excessive actions, Duplicate action, Duplicate Event Trigger, Function resource limit, RIC Request ID unknown, Inconsistent Action/subsequent Action sequence, Control message invalid, RIC Call process ID Invalid, unspecified, ...)	
>>RIC Service	O		ENUMERATED (Function Not Required, Excessive functions, RIC Resource Limit,...)	
>Transport Layer				
>>Transport Layer Cause	M		ENUMERATED (Unspecified, Transport Resource Unavailable, ...)	
>Protocol				
>>Protocol Cause	M		ENUMERATED (Transfer Syntax Error, Abstract Syntax Error (Reject), Abstract Syntax Error (Ignore and Notify), Message not Compatible with Receiver State, Semantic Error, Abstract Syntax Error (Falsely Constructed Message), Unspecified, ...)	
>Misc				
>>Miscellaneous Cause	M		ENUMERATED (Control Processing Overload, Hardware Failure, O&M Intervention, Unspecified, ...)	



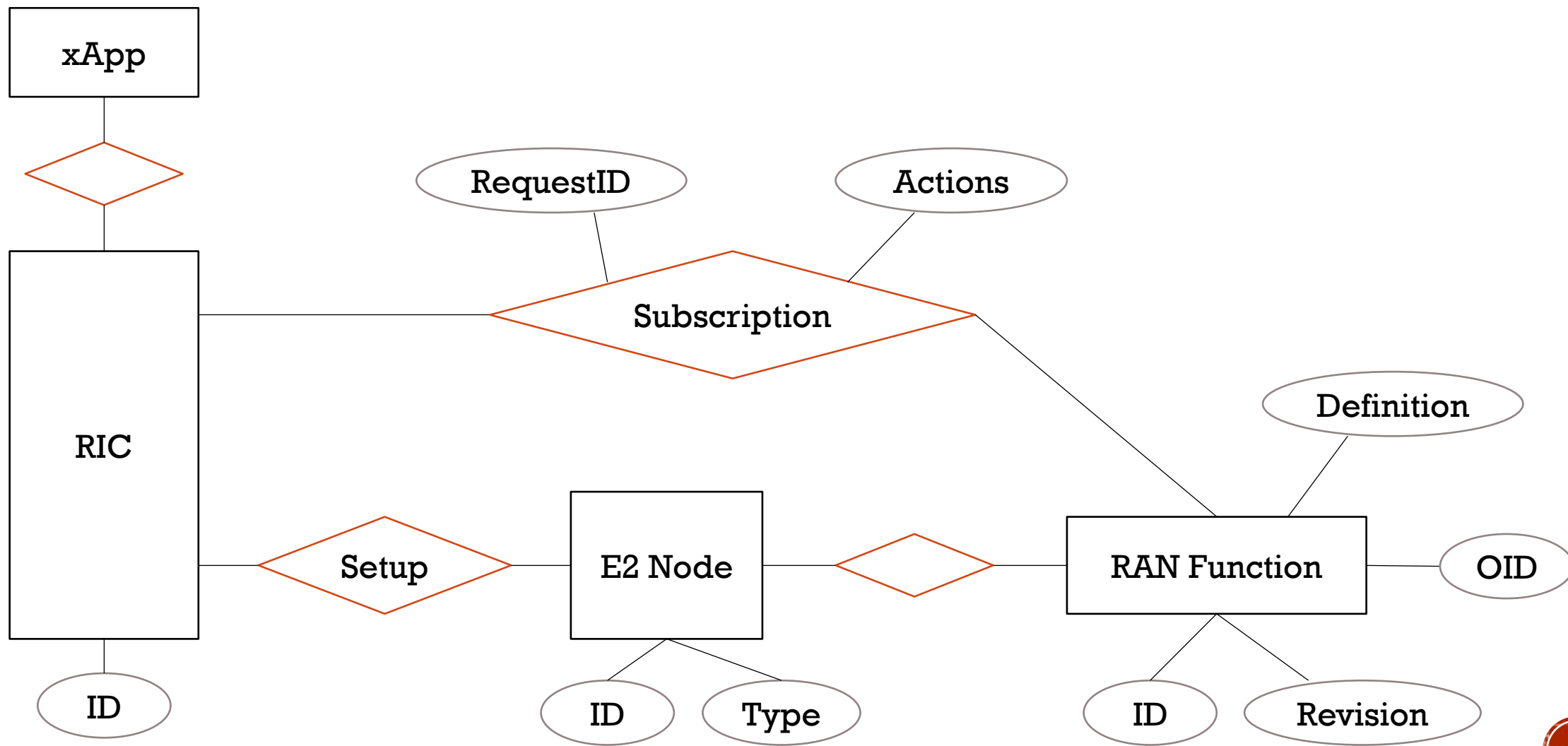
Criticality Diagnostics

IE/Group Name	Presence	Range	IE type and reference	Semantics description
Procedure Code	O		INTEGER (0..255)	Procedure Code is to be used if Criticality Diagnostics is part of Error Indication procedure, and not within the response message of the same procedure that caused the error.
Triggering Message	O		ENUMERATED(initiating message, successful outcome, unsuccessful outcome)	The Triggering Message is used only if the Criticality Diagnostics is part of Error Indication procedure.
Procedure Criticality	O		ENUMERATED(reject, ignore, notify)	This Procedure Criticality is used for reporting the Criticality of the Triggering message (Procedure).
RIC Request ID	O		9.2.7	
Information Element Criticality Diagnostics		<i>0 .. <maxnoof Errors></i>		
>IE Criticality	M		ENUMERATED(reject, ignore, notify)	The IE Criticality is used for reporting the criticality of the triggering IE. The value 'ignore' shall not be used.
>IE ID	M		INTEGER (0..65535)	The IE ID of the not understood or missing IE.
>Type of Error	M		ENUMERATED(not understood, missing, ...)	

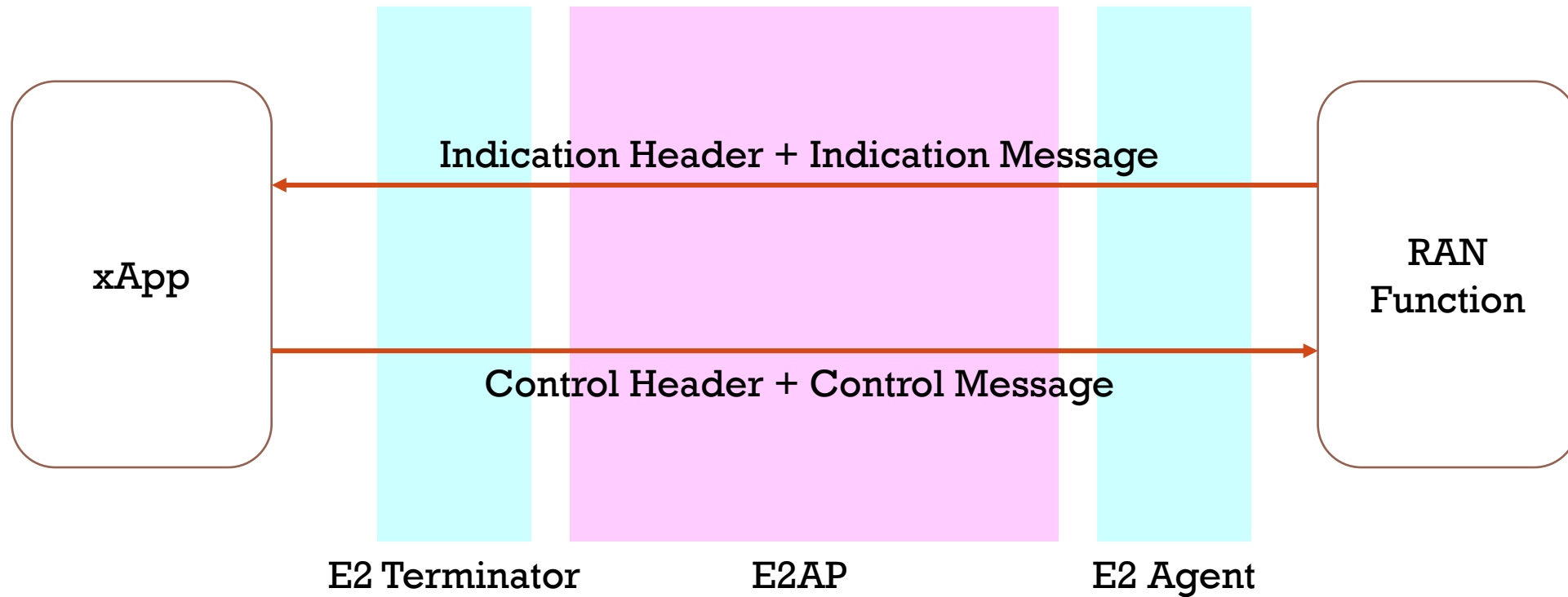
Range bound	Explanation
maxnoofErrors	Maximum no. of IE errors allowed to be reported with a single message. The value for maxnoofErrors is 256.



0-RAN E2主要管理模型



0-RAN E2 Payloads

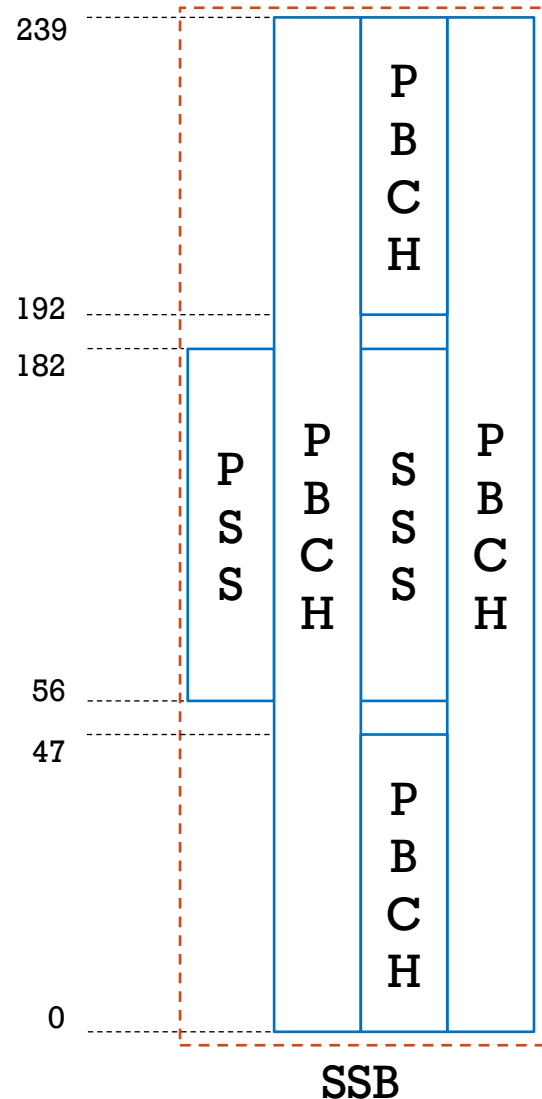


Outlines

- O-RAN E2 詳解
- UE連接過程



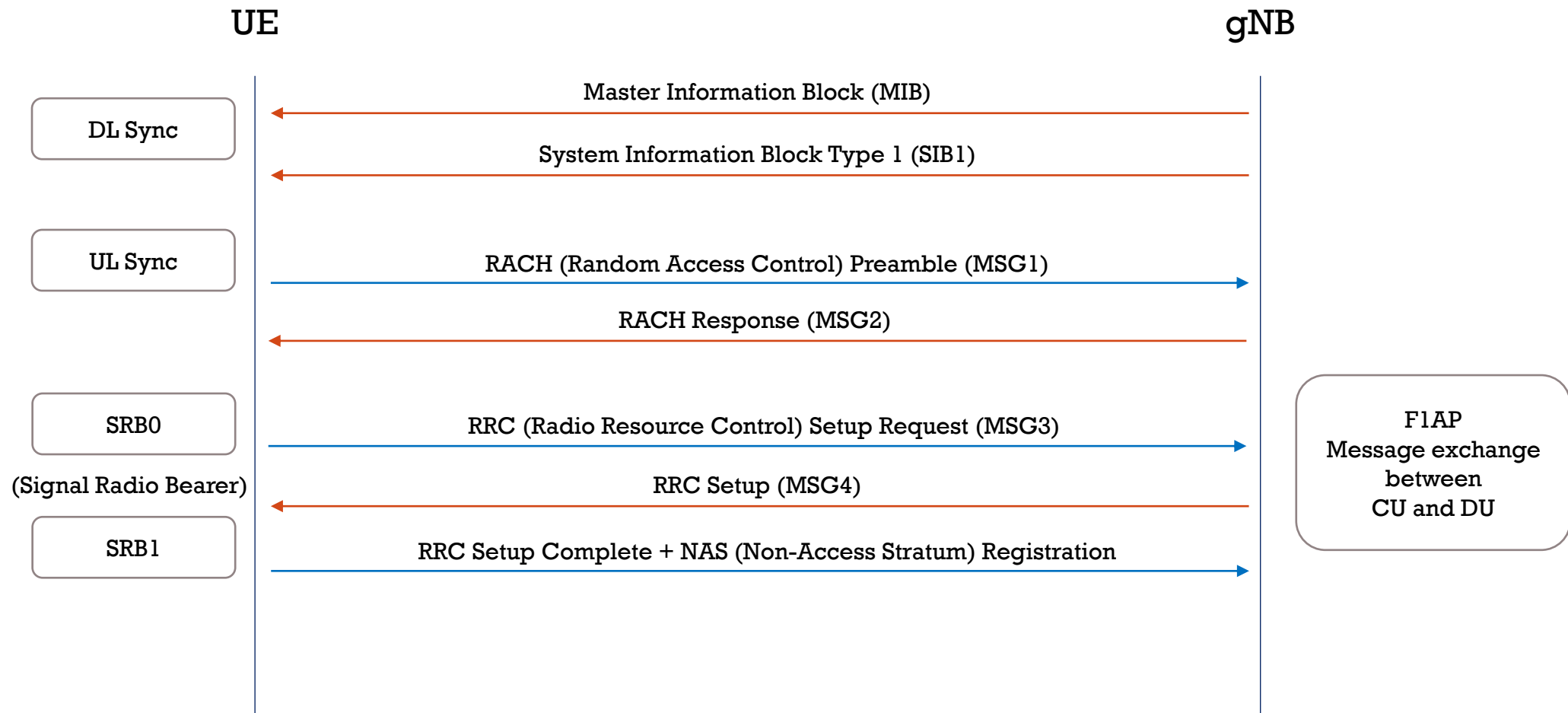
NR同步訊號



- **SSB (Synchronization Signal/PBCH Block)**
 - PSS (Primary Synchronization Signal)
 - SSS (Secondary Synchronization Signal)
 - PBCH (Physical Broadcast Channel)
- **SSB Placement**
 - 4 symbols length
 - Aligned with center frequency, 20 RBs (240 sub-carriers) wide
 - PSS and SSS take 127 sub-carriers
 - SS Burst
 - Multiple SSBs in 5ms (half-frame), burst interval takes 20 ms



UE連接過程



F1AP Class 1 Procedures

Elementary Procedure	Initiating Message	Successful Outcome	Unsuccessful Outcome
		Response message	Response message
Reset	RESET	RESET ACKNOWLEDGE	
F1 Setup	F1 SETUP REQUEST	F1 SETUP RESPONSE	F1 SETUP FAILURE
gNB-DU Configuration Update	GNB-DU CONFIGURATION UPDATE	GNB-DU CONFIGURATION UPDATE ACKNOWLEDGE	GNB-DU CONFIGURATION UPDATE FAILURE
gNB-CU Configuration Update	GNB-CU CONFIGURATION UPDATE	GNB-CU CONFIGURATION UPDATE ACKNOWLEDGE	GNB-CU CONFIGURATION UPDATE FAILURE
UE Context Setup	UE CONTEXT SETUP REQUEST	UE CONTEXT SETUP RESPONSE	UE CONTEXT SETUP FAILURE
UE Context Release (gNB-CU initiated)	UE CONTEXT RELEASE COMMAND	UE CONTEXT RELEASE COMPLETE	
UE Context Modification (gNB-CU initiated)	UE CONTEXT MODIFICATION REQUEST	UE CONTEXT MODIFICATION RESPONSE	UE CONTEXT MODIFICATION FAILURE
UE Context Modification Required (gNB-DU initiated)	UE CONTEXT MODIFICATION REQUIRED	UE CONTEXT MODIFICATION CONFIRM	
Write-Replace Warning	WRITE-REPLACE WARNING REQUEST	WRITE-REPLACE WARNING RESPONSE	
PWS Cancel	PWS CANCEL REQUEST	PWS CANCEL RESPONSE	
GNB-DU RESOURCE COORDINATION	GNB-DU RESOURCE COORDINATION REQUEST	GNB-DU RESOURCE COORDINATION RESPONSE	



F1AP Class 2 Procedures

Elementary Procedure	Message
Error Indication	ERROR INDICATION
UE Context Release Request (gNB-DU initiated)	UE CONTEXT RELEASE REQUEST
Initial UL RRC Message Transfer	INITIAL UL RRC MESSAGE TRANSFER
DL RRC Message Transfer	DL RRC MESSAGE TRANSFER
UL RRC Message Transfer	UL RRC MESSAGE TRANSFER
UE Inactivity Notification	UE INACTIVITY NOTIFICATION
System Information Delivery	SYSTEM INFORMATION DELIVERY COMMAND
Paging	PAGING
Notify	NOTIFY
PWS Restart Indication	PWS RESTART INDICATION
PWS Failure Indication	PWS FAILURE INDICATION
gNB-DU Status Indication	GNB-DU STATUS INDICATION



gNB與UE間的信道

- PDCCH
 - Physical Downlink Control Channel
- PDSCH
 - Physical Downlink Shared Channel
- PUCCH
 - Physical Uplink Control Channel
- PUSCH
 - Physical Uplink Shared Channel

