

E2 INTERFACE – THE E2 APPLICATION PROTOCOL (E2AP)

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What is the E2 Interface?



An open interface designed for communication between the near-RT RIC and the E2 Nodes (CU/CU-CP/CU-UP/DU).



E2 Application Protocol (E2AP) is the basic procedural protocol that co-ordinates communication between near-RT RIC and E2 nodes.



Every RIC and CU/DU should follow E2AP (same message structure and procedures).



RAN Function Specific messages are conveyed through E2 Service Models (E2SM)

E2AP/E2SM
Messages

E2AP

SCTP

IP

E2 Interface Protocol Stack

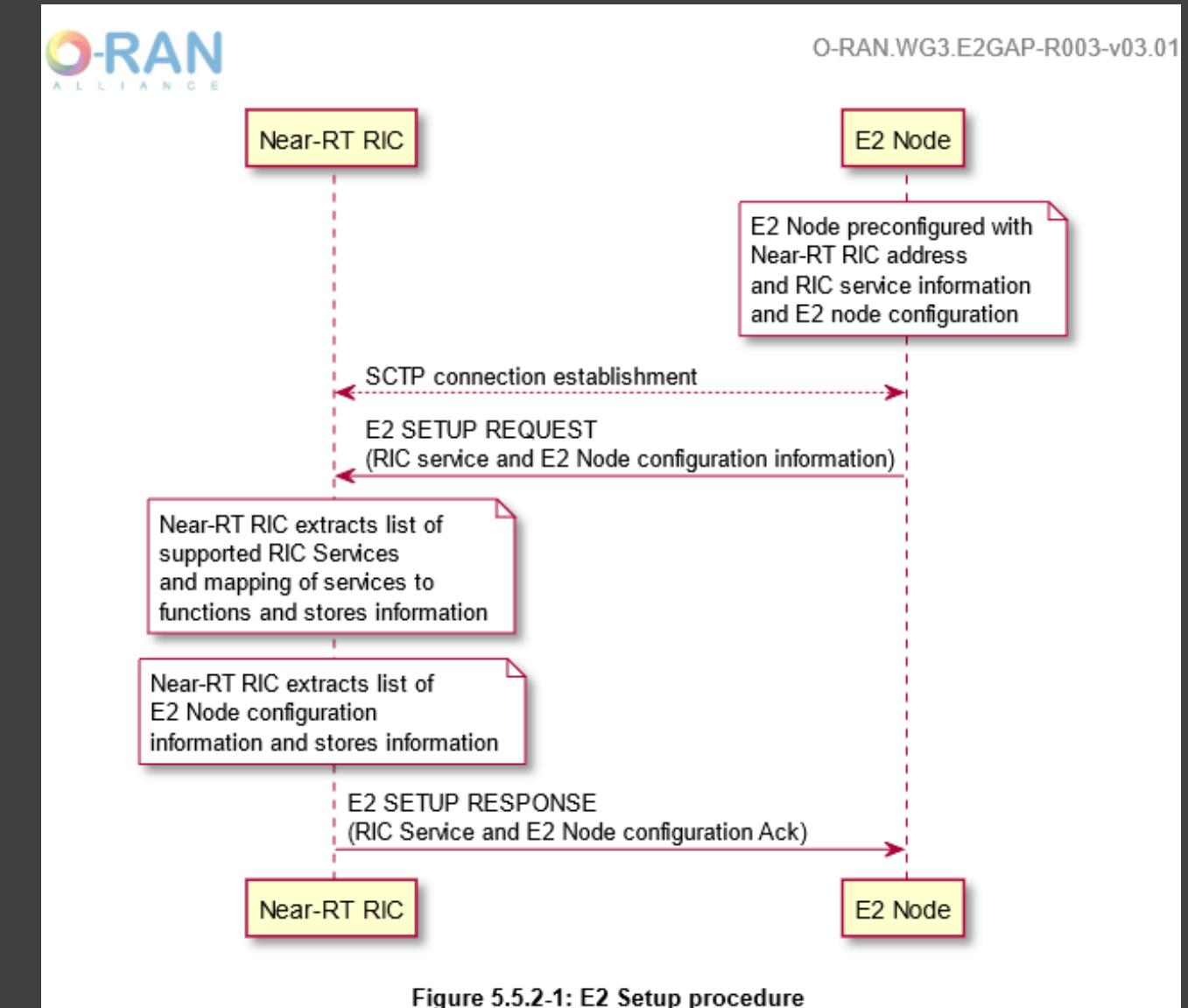
E2AP Terminology

- RAN Function: A specific Function in an E2 Node (Ex: UE context handling, paging, Handover, Cell (re)configuration etc.)
 - RAN Function ID: Identifier of a specific RAN function.
- RIC Service: A service provided on an E2 Node.
 - E2 Node provides access to messages, measurements, and/or enables control from the near-RT RIC.
 - RIC Action ID: Identifier of the specific RIC service action.
- Information Elements (IE): A data item containing a label field, a length indicator and a value.
- Message: Group of Information Elements organized in a specific manner (often nested several levels deep). (Ex: E2 Setup Request, Setup Response, Subscription Request).
- Procedure: Sequential exchange of a set of messages (Ex: Setup Procedure, Subscription Procedure, Removal, Handover procedure etc.).

E2AP MESSAGE

```
Frame 295: 326 bytes on wire (2608 bits), 326 bytes captured (2608 bits) on interface lo, id 0
Ethernet II, Src: 00:00:00:00:00:00 (00:00:00:00:00:00), Dst: 00:00:00_00:00:00 (00:00:00:00:00:00)
Internet Protocol Version 4, Src: 127.0.0.1, Dst: 127.0.0.1
Stream Control Transmission Protocol, Src Port: 48923 (48923), Dst Port: 36421 (36421)
E2 Application Protocol
  E2AP-PDU: initiatingMessage (0)
    initiatingMessage
      procedureCode: id-E2setup (1)
      criticality: reject (0)
    value
      E2setupRequest
        protocolIEs: 4 items
          Item 0: id-TransactionID
            ProtocolIE-Field
              id: id-TransactionID (49)
              criticality: reject (0)
            value
              TransactionID: 0
          Item 1: id-GlobalE2node-ID
            ProtocolIE-Field
              id: id-GlobalE2node-ID (3)
              criticality: reject (0)
            value
              GlobalE2node-ID: gNB (0)
          Item 2: id-RANfunctionsAdded
            ProtocolIE-Field
              id: id-RANfunctionsAdded (10)
              criticality: reject (0)
            value
              RANfunctions-List: 1 item
                Item 0: id-RANfunction-Item
                  ProtocolIE-SingleContainer
                    id: id-RANfunction-Item (8)
                    criticality: ignore (1)
                  value
                    RANfunction-Item
                      ranFunctionID: 147
                      ranFunctionDefinition: 60304f52414e2d4532534d2d4b504d000018312e332e362e312e342e312e35333134382e...
                  E2SM-KPM-RANfunction-Description
                    ranFunction-Name
                    ric-EventTriggerStyle-List: 1 item
                      Item 0
                        RIC-EventTriggerStyle-Item
                          ric-EventTriggerStyle-Type: 1
                          ric-EventTriggerStyle-Name: Periodic Report
                          ric-EventTriggerFormat-Type: 1
                      ric-ReportStyle-List: 1 item
                        ranFunctionRevision: 0
                        ranFunctionOID: 1.3.6.1.4.1.53148.1.2.2.2
                Item 3: id-E2nodeComponentConfigAddition
                  ProtocolIE-Field
                    id: id-E2nodeComponentConfigAddition (50)
                    criticality: reject (0)
```

E2 SETUP PROCEDURE



Types of E2AP Procedures

RIC Functional Procedures:

Procedures used to pass application specific messages between near-RT RIC applications and a target RAN function.

- Support RIC Services – Help in getting information and events from E2 node to provide policy/control information back to E2 node

Global Procedures:

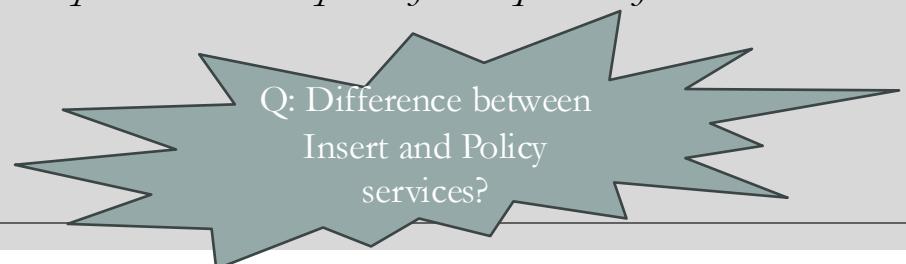
Procedures not directly related to a specific application (Ex: E2 Setup, Reset, Removal, RIC service update, RIC Query etc.)

- Support Interface Management – Setup and maintenance of the E2 link between the E2 node and near-RT RIC.

RIC Services - Types

- **Report Service:** The Report Service is triggered to send RIC Indication messages (of type **report**) that can contain data and telemetry from an E2 Node, upon subscription from an xApp.
 - The report messages can be configured to be sent periodically during subscription.
- **Insert Service:** Through the Insert service an xApp can suspend a specific procedure upon event trigger (through subscription) and get details about suspended procedures through RIC Indication messages (of type **insert**).
 - The procedure can be halted till a timer expires/till a RIC control message is received.
- **Control Service:** The E2 node can receive RIC Control messages triggered autonomously by the RIC (xApp) or due to the consequence of reception of an Insert message.
- **Policy Service:** The policy service allows an xApp to request the E2 node to execute a specific policy (through a Subscription Message) after the occurrence of a specific event.
 - No halting of any procedure. The E2 node adopts the policy specified.
- **Query Service:** The E2 Node allows the RIC (xApp) to query RAN/UE-specific information.

RIC services can be combined within a common subscription with each RIC service implemented as a part of a sequence of actions.



E2 Service Models (E2SM)



Each RAN Function is associated with one or more E2 Service Models.



The RIC services provided by the RAN function, the message types used, and their styles are specified in the E2 Service Model.



The Service Model also contains description of RAN function dependent Information Elements used in the E2 messages.



xApps need to have the same service Model definitions to effectively communicate with the RAN functions.

O-RAN

Standardized

Service Models



Table 5-2: O-RAN specified E2 Service Models and related OIDs

E2SM short name	OID	Syntax language	Scope
E2SM-NI	iso(1) identified-organization(3) dod(6) internet(1) private(4) enterprise(1) 53148 e2(1) version1 (1) e2sm(2) e2sm-NI-IEs (1)	ASN.1	RAN Function NI "Network Interface" performs the following functionalities: <ul style="list-style-type: none"> - Exposure of Network Interfaces - Modification of both incoming and outgoing network interface message contents - Execution of policies that may result in change of network behavior
E2SM-KPM version1	iso(1) identified-organization(3) dod(6) internet(1) private(4) enterprise(1) 53148 e2(1) version1 (1) e2sm(2) e2sm-KPM-IEs (2)	ASN.1	RAN function KPM "KPM Monitor" performs the following functionalities: <ul style="list-style-type: none"> - Exposure of O-DU's cell related performance IEs through periodic KPM Report. - Exposure of O-CU-CP's cell/UE related performance IEs through periodic KPM Report. - Exposure of O-CU-UP's bearer related performance IEs through periodic KPM Report
E2SM-KPM version2	iso(1) identified-organization(3) dod(6) internet(1) private(4) enterprise(1) 53148 e2(1) version2 (2) e2sm(2) e2sm-KPM-IEs (2)	ASN.1	RAN function KPM "KPM Monitor" performs the following functionalities: <ul style="list-style-type: none"> - Exposure of available measurements from O-DU, O-CU-CP, and/or O-CU-UP via the RAN Function Definition IE. - Periodic reporting of measurements subscribed from Near-RT RIC.
E2SM-RC	iso(1) identified-organization(3) dod(6) internet(1) private(4) enterprise(1) 53148 e2(1) version1 (1) e2sm(2) e2sm-RC-IEs (3)	ASN.1	RAN function RC "RAN Control" performs the following functionalities: <ul style="list-style-type: none"> - Exposure of RAN control and UE context related information. - Modification and initiation of RAN control related call processes and messages - Execution of policies that may result in change of RAN control behavior
E2SM-CCC	iso(1) identified-organization(3) dod(6) internet(1) private(4) enterprise(1) 53148 e2(1) version1 (1) e2sm(2) e2sm-CCC-IEs (4)	JSON	RAN function CCC "Cell Configuration and Control" performs the following functionalities: <ul style="list-style-type: none"> - Exposure of node level and cell level configuration information - Initiate control and/or configuration of node level and cell level parameters

E2SM-KPM

- The Key Performance Metrics (KPM) Monitor RAN function exposes available measurements from O-DU, O-CU-CP, O-CU-UP and periodically reports measurements subscribed from near-RT RIC (xApp).
- The KPM Monitor RAN function provides the **Report** service in the following styles
 - E2 Node Measurement.
 - E2 Node Measurement for a single UE.
 - Condition-based, UE-level E2 Node Measurement.
 - Common Condition-based, UE-level E2 Node Measurement.
 - E2 Node Measurements for multiple UEs.

RIC Style Type	Style Name	Style Type Description
1	E2 Node Measurement	Used to carry measurement report from a target E2 Node
2	E2 Node Measurement for a single UE	Used to carry measurement report for a single UE of interest from a target E2 Node
3	Condition-based, UE-level E2 Node Measurement	Used to carry UE-level measurement report for a group of UEs per measurement type matching subscribed conditions from a target E2 Node
4	Common Condition-based, UE-level Measurement	Used to carry measurement report for a group of UEs across a set of measurement types satisfying common subscribed conditions from a target E2 Node
5	E2 Node Measurement for multiple UEs	Used to carry measurement report for multiple UE of interest from a target E2 Node

Style Type: A specific approach used to expose a given RIC service.

Format Type: A specific approach used to encode one of the E2AP IEs defined in the E2SM.

8.2.1.4.1 E2SM-KPM Indication Message Format 1

IE/Group Name	Presence	Range	IE type and reference	Semantics description
Measurements Data		1.. <maxnoofMeasurementRecord>		Contains a set of Measurement Records, each collected at each Granularity Period.
>Measurements Record		1.. <maxnoofMeasurementValue>		Contains measured values in same order as in the Measurements Information List IE if present, otherwise in the order defined in the subscription.
>>CHOICE Measured Value				
>>>Integer Value	M		INTEGER (0..4294967295)	
>>>Real Value	M		REAL	
>>>No Value	M		NULL	
>Incomplete Flag	O		ENUMERATED (true,...)	Indicates that the measurements record is not reliable.
Measurement Information List		0.. <maxnoofMeasurementInfo>		
>CHOICE Measurement Type				
>>Measurement Name	M		8.3.9 Measurement Type Name	
>>Measurement ID	M		8.3.10 Measurement Type ID	
>List of Labels		1.. <maxnoofLabelInfo>		
>>Label Information	M		8.3.11 Measurement Label	
Granularity Period	O		8.3.8 Granularity Period	Collection interval of measurements

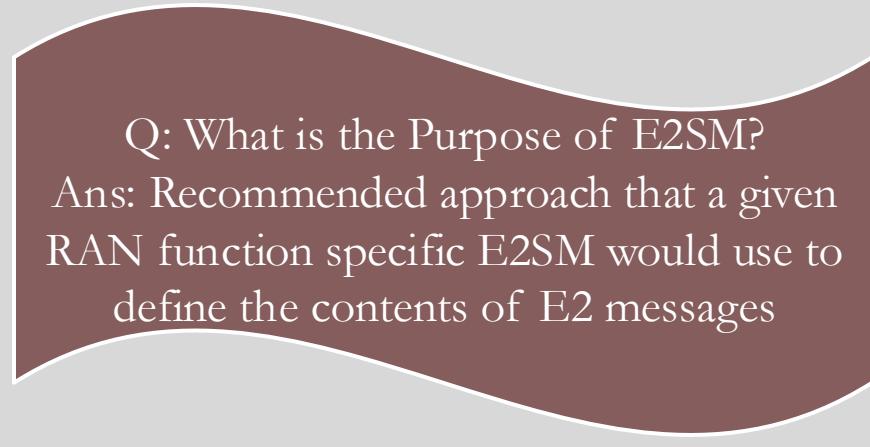
8.2.1.4.3 E2SM-KPM Indication Message Format 3

IE/Group Name	Presence	Range	IE type and reference	Semantics description
List of UE Measurement Reports		1.. <maxnoofUEMeasReport>		
>UE ID	M		8.3.24	
>Measurements Report	M		8.2.1.4.1 E2SM-KPM Indication Message Format 1	Contains Measurement Data for a UE for a Reporting Period.

E2-SM Message formats

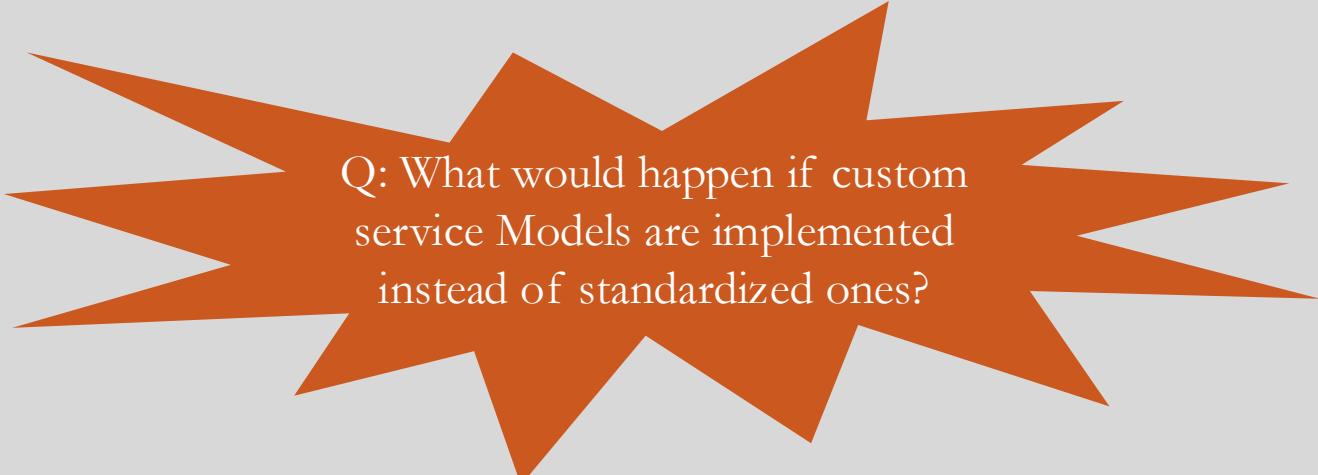


Explore ASN1 file
for E2SM-KPM



Q: What is the Purpose of E2SM?

Ans: Recommended approach that a given RAN function specific E2SM would use to define the contents of E2 messages



Q: What would happen if custom
service Models are implemented
instead of standardized ones?

Apply a display filter ... <Ctrl-/>						
No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000			E2AP	953	E2setupRequest
2	0.000620			E2AP	60	E2setupResponse
▶ Frame 1: 953 bytes on wire (7624 bits), 953 bytes captured (7624 bits) DLT: 155, Payload: e2ap (E2 Application Protocol)						
E2 Application Protocol <ul style="list-style-type: none"> ▪ E2AP-PDU: initiatingMessage (0) ▪ initiatingMessage <ul style="list-style-type: none"> procedureCode: id-E2setup (1) criticality: reject (0) ▪ value <ul style="list-style-type: none"> ▪ E2setupRequest <ul style="list-style-type: none"> ▪ protocolIEs: 4 items <ul style="list-style-type: none"> ▪ Item 0: unknown (49) <ul style="list-style-type: none"> ▪ ProtocolIE-Field <ul style="list-style-type: none"> id: Unknown (49) criticality: reject (0) value ▪ Item 1: id-GlobalE2node-ID <ul style="list-style-type: none"> ▪ ProtocolIE-Field <ul style="list-style-type: none"> id: id-GlobalE2node-ID (3) criticality: reject (0) ▪ value <ul style="list-style-type: none"> ▪ GlobalE2node-ID: gNB (0) <ul style="list-style-type: none"> ▪ gNB <ul style="list-style-type: none"> ▪ global-gNB-ID <ul style="list-style-type: none"> plmn-id: 00f110 ▪ gnb-id: gnb-ID (0) <ul style="list-style-type: none"> gnb-ID: 000019b0 [bit length 28, 4 LSB pad bits, 0000 0... ▪ Item 2: id-RANfunctionsAdded <ul style="list-style-type: none"> ▪ ProtocolIE-Field <ul style="list-style-type: none"> id: id-RANfunctionsAdded (10) criticality: reject (0) ▪ value <ul style="list-style-type: none"> RANfunctions-List: 0 items ▪ Item 3: unknown (50) <ul style="list-style-type: none"> ▪ ProtocolIE-Field <ul style="list-style-type: none"> id: Unknown (50) criticality: reject (0) value 						
0000	00	01	00	83	b4	00 00 04 00 31
0010	00	09	00	00	f1	10 30 00 00 19
0020	00	00	08	40	83	6d 00 00 93 83
0030	4e	2d	45	32	53	4d 2d 4b 50 4d
0040	2e	36	2e	31	2e	34 2e 31 2e 35
0050	2e	32	2e	32	2e	32 05 00 4b 50
0060	74	6f	72	00	01	01 07 00 50 65
0070	20	52	65	70	6f	72 74 01 01 10
0080	20	4e	6f	64	65	20 4d 65 61 73
0090	74	01	01	00	05	00 40 43 51 49
00a0	00	60	52	53	52	51 02 c0 44 52
00b0	61	63	6b	65	74	44 72 6f 70 52
00c0	80	44	52	42	2e	52 6c 63 53 64
00d0	6d	69	74	74	65	64 56 6f 6c 75
00e0	44	52	42	2e	52	6c 63 53 64 75
00f0	69	74	74	65	64	56 6f 6c 75 6d
0100	01	00	01	02	11	00 45 32 20 4e
0110	61	73	75	72	65	6d 65 6e 74 20
0120	73	69	6e	67	6c	65 20 55 45 01
0130	51	49	00	60	52	53 52 50 00 60
0140	44	52	42	2e	52	6c 63 50 61 63
0150	70	52	61	74	65	44 6c 03 80 44
0160	53	64	75	54	72	61 6e 73 6d 69
0170	6c	75	6d	65	44	4c 03 80 44 52
0180	64	75	54	72	61	6e 73 6d 69 74
0190	75	6d	65	55	4c	01 01 01 01 00
01a0	6e	64	69	74	69	6f 6e 2d 62 61
01b0	45	2d	6c	65	76	65 6c 20 45 32
01c0	4d	65	61	73	75	72 65 6d 65 6e
01d0	40	43	51	49	00	60 52 53 52 50
01e0	02	c0	44	52	42	2e 52 6c 63 50
01f0	72	6f	70	52	61	74 65 44 6c 03
0200	6c	63	53	64	75	54 72 61 6e 73
0210	56	6f	6c	75	6d	65 44 4c 03 80
0220	63	53	64	75	54	72 61 6e 73 6d
0230	6f	6c	75	6d	65	55 4c 01 01 01
0240	43	6f	6d	6f	6e	20 43 6f 6e
0250	2d	62	61	73	65	64 2c 20 55 45
0260	20	4d	65	61	73	75 72 65 6d 65

E2 Packet Captures (E2 Setup Request)

Apply a display filter ... <Ctrl-/>						
No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000			E2AP	953	E2setupRequest
2	0.000620			E2AP	60	E2setupResponse
Frame 2: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) DLT: 155, Payload: e2ap (E2 Application Protocol)						
E2 Application Protocol						
E2AP-PDU: successfulOutcome (1)						
successfulOutcome						
procedureCode: id-E2setup (1)						
criticality: reject (0)						
value						
E2setupResponse						
protocolIEs: 4 items						
Item 0: unknown (49)						
ProtocolIE-Field						
id: Unknown (49)						
criticality: reject (0)						
value						
Item 1: id-GlobalRIC-ID						
ProtocolIE-Field						
id: id-GlobalRIC-ID (4)						
criticality: reject (0)						
value						
GlobalRIC-ID						
pLMN-Identity: 00f110						
ric-ID: 000190 [bit length 20, 4 LSB pad bits, 0000 0000 0000...]						
Item 2: id-RANfunctionsAccepted						
ProtocolIE-Field						
id: id-RANfunctionsAccepted (9)						
criticality: reject (0)						
value						
RANfunctionsID-List: 0 items						
Item 3: unknown (52)						
ProtocolIE-Field						
id: Unknown (52)						
criticality: reject (0)						
value						

E2 Packet Captures (E2 Setup Response)

