IETF-98-Deploying ICN for 3G LTE 4G Mobile Networks

draft-ietf-suthar-icn-lte-00 (submission in progress)

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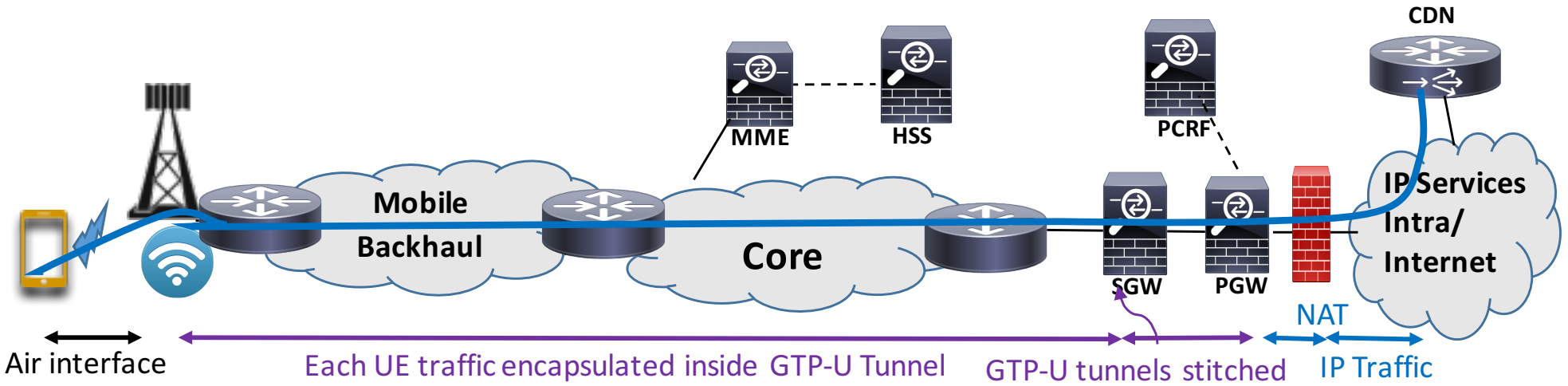
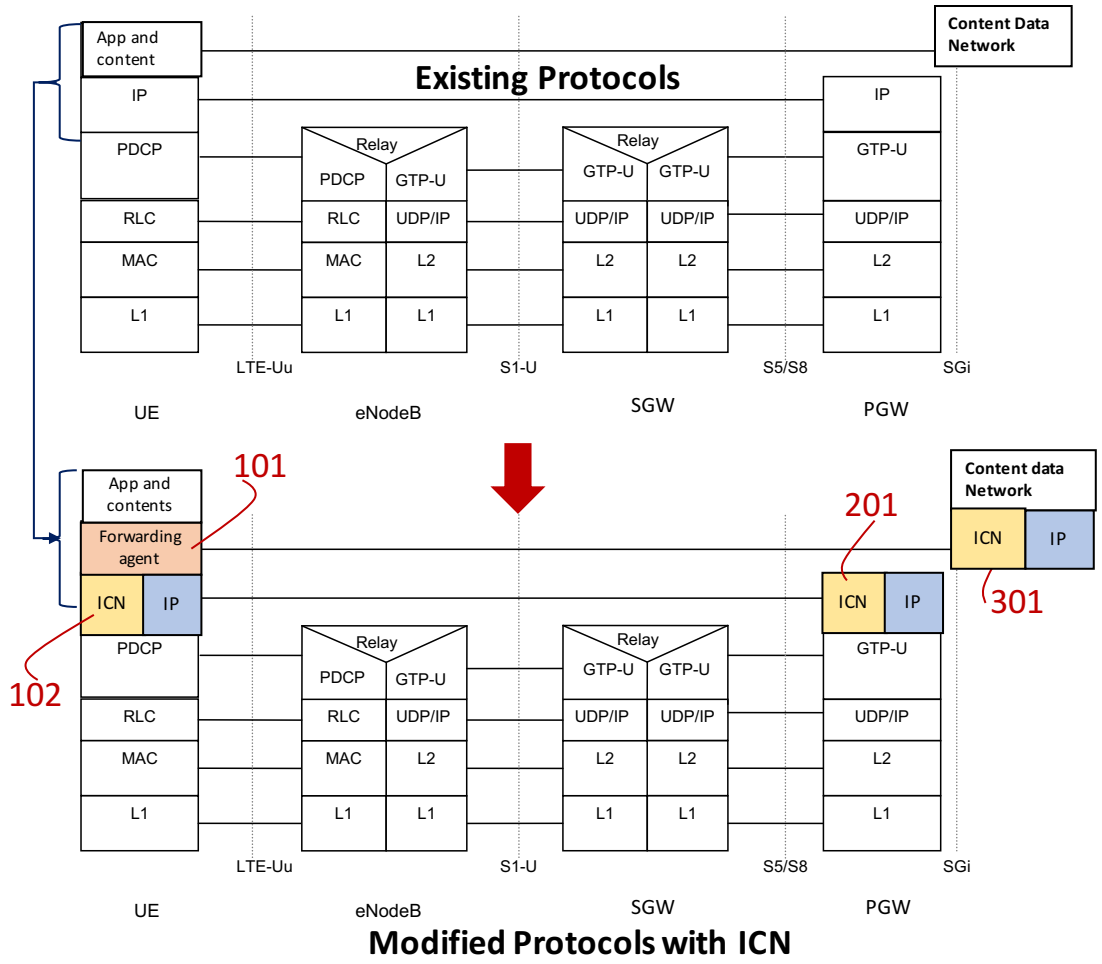
3G/LTE cellular network



- Overall cellular network complex
- UE has to attach to network before it can send/receive data
- UE can be consumer and publisher

Overall Protocol Changes with ICN

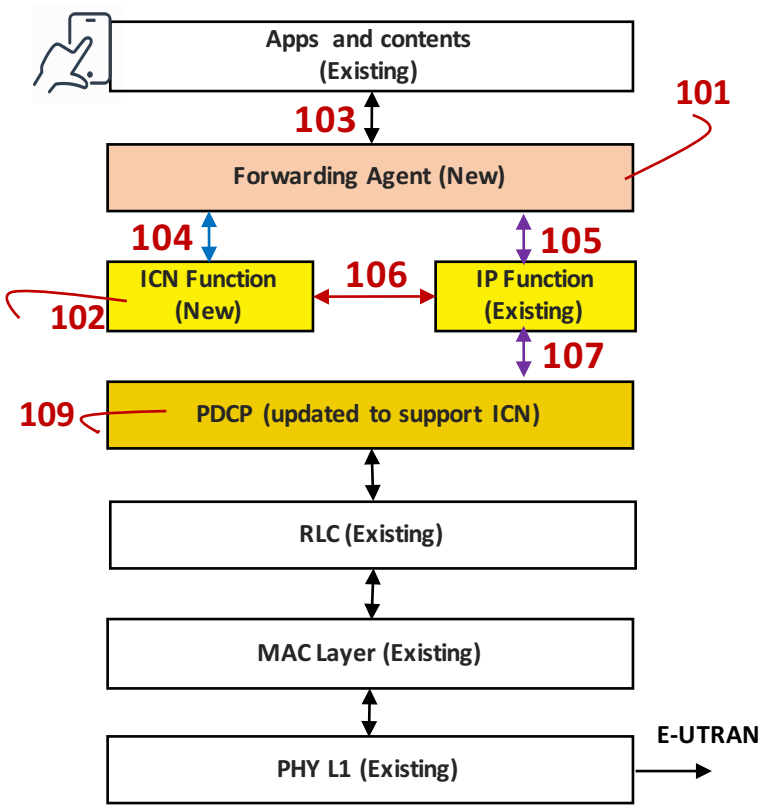
101. Insert **Forwarding Agent** function between Application and network layer. Forwarding agent interface with Application layer and it contains forwarding decisions algorithms to route request based on criteria such as application preference (ICN vs IP transport), content locations, content types, publishers details, cost, network congestions, QoS and any other customizable parameters (For example forwarding agent can monitor application layer parameters through software probes to find out network status, preference etc. and apply this to algorithms)
102. Introduction of new layer "ICN + IP Function" by modifying existing PDCP and IP layer to insert **ICN function** (includes ICN stack, ICN forwarding strategy). For dual stack, ICN protocol will use overlay over IP. This ICN function can communicate either ICN function in PDN GW (201) if ICN is implemented in PGW or ICN function in CDN (301) based upon how it is implemented in network
201. ICN function is incorporated in PGW to support UE attach procedures for UE supporting ICN. Once device registration is done using ICN then, UE can communicate with PGE natively using ICN protocol.
301. Incorporating ICN function in Content Data Network (CDN) hosting video and other contents. This is used for communication between UE and CDN using ICN protocol. ICN function in CDN is useful for all cases e.g. ICN over IP, native ICN etc.



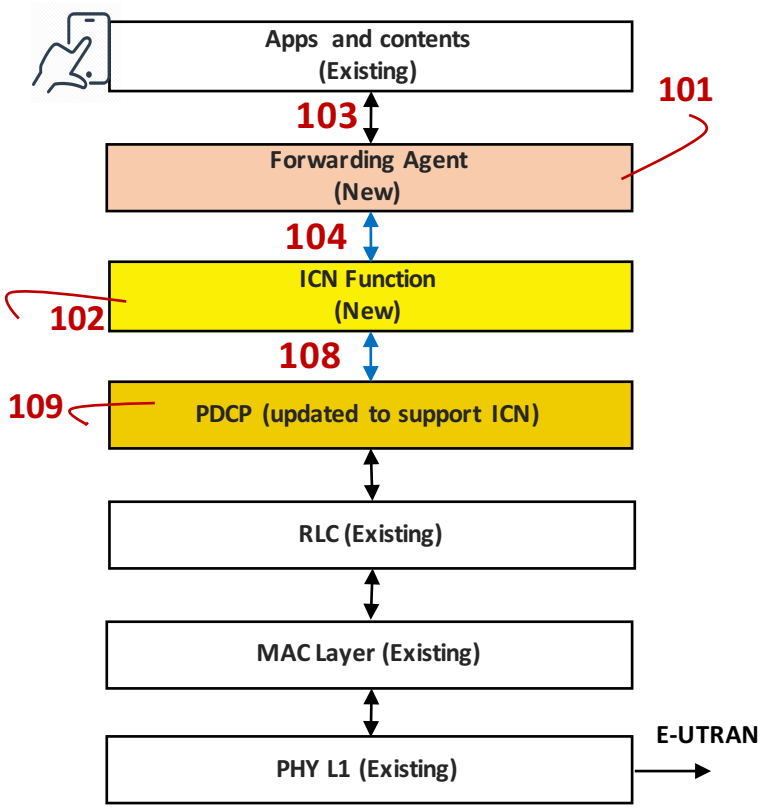
User Equipment (UE)* - includes all different types of conventional smart phones and unconventional IOT devices using 2G, 3G and LTE mobile technologies

Implementing ICN in UE

Dual/Triple* Stack UE (IPv4, IPv6, ICN)



Native ICN UE

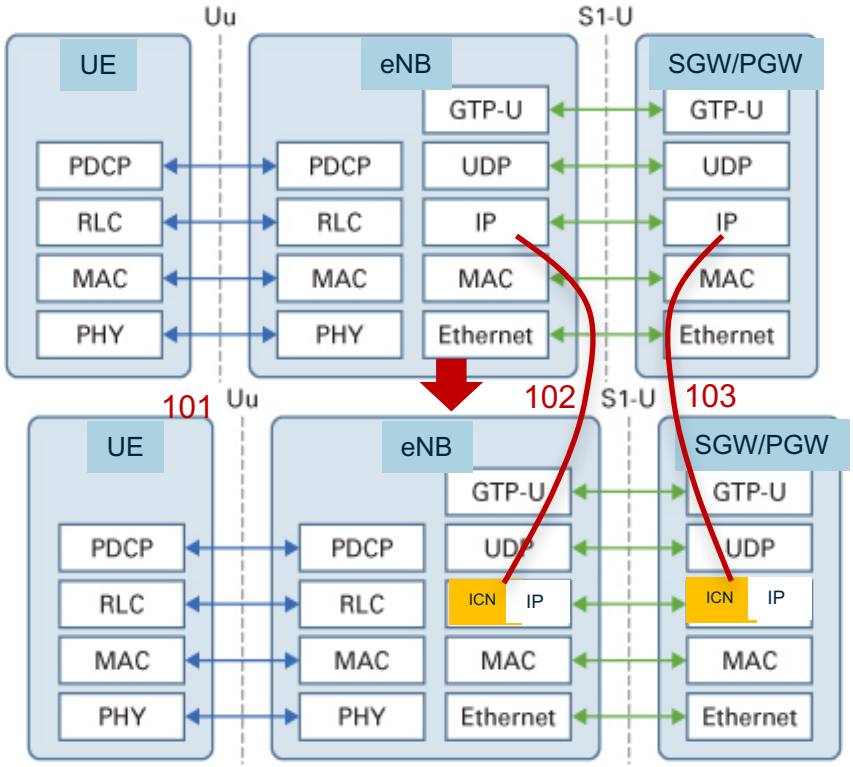


2) Implementing ICN in Base Station (BS) for User Plane (1/3)

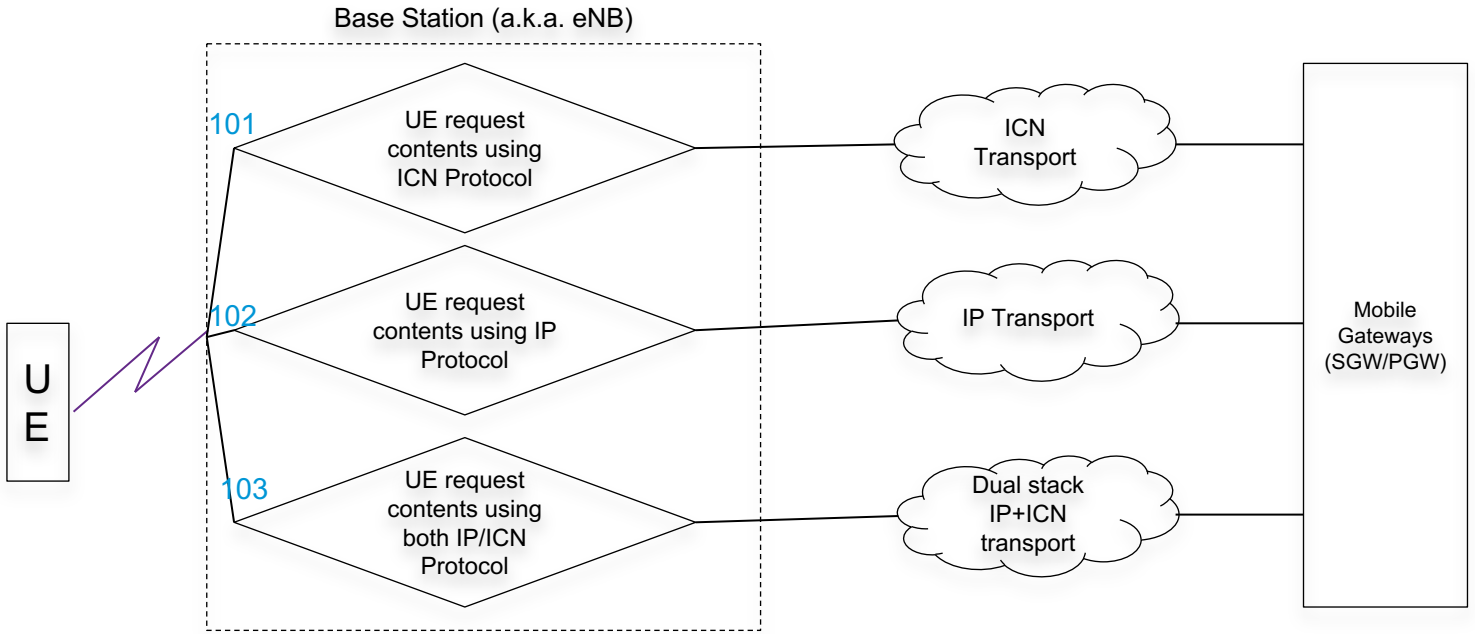
To deploy information centric networking (ICN) in radio Base Station (a.k.a. as eNodeB) for LTE/4G network in user plane, we need to modify existing Layer-3 (Internet Protocol layer). At layer-3 we need to incorporate ICN function in additional existing IP function.

101. When UE is powered-up, it will perform attach procedures and on successful attachment, UE can have either ICN or IP or both ICN + IP identity. When user initiate any application on UE, the request to get content can come to BS, the request is forwarded by to SGW/PGW using following order
    101. UE send ICN request > BS forward request using ICN either natively (if transport exist) or ICN as overlay on IP (If transport is IP)
    102. UE send IP request > BS forward request using IP natively (If transport is IP). Transport is built either dual stack (IP +ICN) or native IP. More details about algorithms used in BS is given in next slide.
    103. UE send ICN or IP request, then such request is received with additional qualifier such as weight, priority, cost etc. BS will use algorithms. have built in logic to interpret either priority of > BS forward request using IP natively (If transport is IP). Transport is built either dual stack (IP +ICN) or native IP

102. In Base Station ICN function incorporated at network layer (IP) on S1-U interface between eNB and SGW. Existing IP based S1-U interface is modified to support dual stack (ICN and IP routing) and this interface is used to carry user plane traffic inside GTP tunnel.
    - For dual stack (ICN and IP) capable UE, when ***Interest*** *or* ***Data*** packet is received, ICN protocol will be used to process. At transport layer if S1-U is supporting IP routing then ICN messages will be overlay on top of IP. When request for content delivery is received on IP, it will follow standard S1-U interface
    - For native ICN capable UE, when ***Interest*** *or* ***Data*** packet is received, ICN protocol will be used to process. At transport layer if S1-U is supporting IP routing then ICN messages will be overlay on top of IP.
    - Since ICN function in BS which will capability for content caching for local delivery.
103. Corresponding ICN function is implemented at SGW/PGW/CDN to support ICN based routing at Base Station. Using ICN function content can be cached in PGW/CDN.



Implementing ICN in Base Station (BS) for User Plane



In order deploy information centric networking (ICN) in radio Base Station (Base Station, a.k.a. as eNodeB in attached diagram) for LTE/4G network for user plane traffic, we need to modify existing Layer-3 (Internet Protocol layer). At layer-3 we need to incorporate ICN function in additional existing IP function. When UE is powered on, it will perform attach procedures/steps outlined in 3GPP TS23.401 and other associated procedures. On successful attachment, UE is attached to mobile gateways using either ICN or IP or both ICN + IP based identity.

One UE is attached successfully to mobile gateways, it send request to BS, using following order

101. UE send content request using ICN protocol > BS process the request and forward to using ICN transport. If ICN transport is not provisioned then it will use ICN protocol as an overlay on IP
102. UE send content request using IP protocol > BS forward request using IP natively. Transport is built either dual stack (IP +ICN) or native IP
103. UE send content request using ICN and IP protocol both. In this case UE send either additional information such as weight, priority, time of day, location, cost etc. BS will use algorithms to determine best path for fetching content. This option is likely to provide more choices for fetching bulk contents very inexpensively.

Implementing ICN in EPC[$]

Modified Attach Procedures

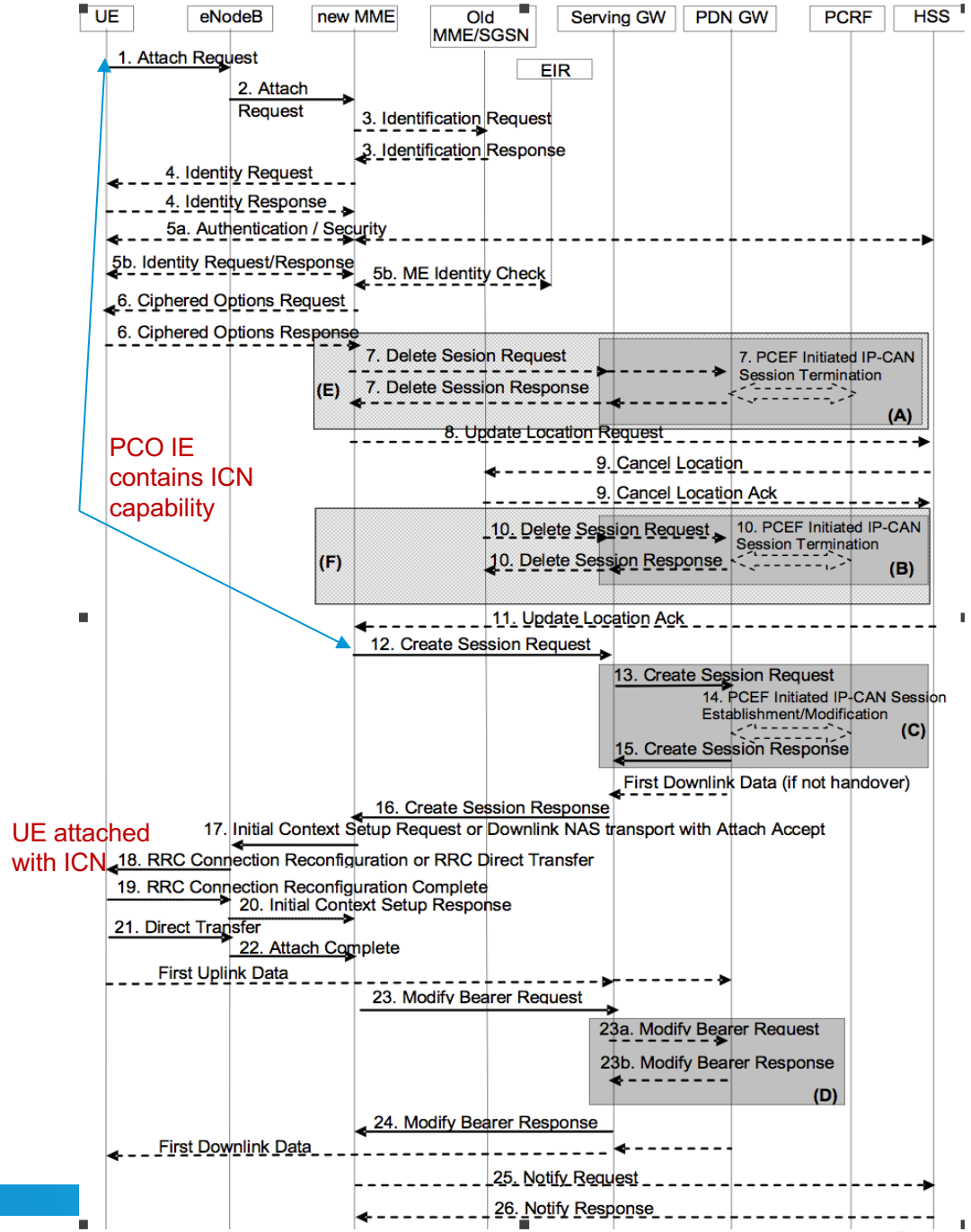
3GPP TS 23.401 V13.6.1 (2016-03) section 5.3.2.1 covers attach procedure. This require modification is step 12 to 22 (because of additional parameters ICN capability is populated in PCO IE TLV. Modified steps will support enhanced capabilities in PGW to support ICN attach in addition to normal IP attach procedures.

1. UE send initial attach request. ICN capable device will send PCO IE field populated (Details provided in previous section) with ICN capability
2. BS (eNB) will forward attach request to MME. NAS signaling (step 3 to 6) will be performed to authenticate the UE. There is no modification for steps 7 to 11.

12. When attach request is successful, PGW/GGSN assign identity to UE and create session using PDN types. Type of attach is communicated to UE in step-16.

16. For UE requesting attach using PDN Type=IP, then PGW will assign either IPv4 or IPv6 (Link local) in create session response (CSR). For PDN type = ICN, PGW will register UE with named identity. This will be used for creation of session and all context related function (billing, mediation, enhanced charring function/deep packet inspection, lawful intercept etc.) in function. For

Evolved Packet Core (EPC)[$] - Mobile Gateways hosting any or all functionalities of Serving Gateway (SGW), PDN Gateway (PGW), GGSN etc.



Backup slides (Additional Materials)

Implement ICN in EPC[$]

Modified Protocol Configuration (PCO IE) for ICN

3GPP TS 24.008 V13.5.0 (March 2016), Figure 10.5.136/3GPP TS 24.008 and table 10.5.154/3GPP TS 24.008 *Protocol configuration options* information elements provides details for different fields.

110. Octet 3 (configuration protocols defines PDN types) which contains details about IPv4, IPv6, both or ICN.

111. Any combination of Octet 4 to Z can be used to provide additional information related to ICN capability. It is most important that PCO IE parameters are matched between UE and EPC gateways (MME, SGW, PGW) so that they can be interpreted properly and UE can attach successfully

Evolved Packet Core (EPC)[$] - Mobile Gateways hosting any or all functionalities of Serving Gateway (SGW), PDN Gateway (PGW), GGSN etc.