3GPP TSG RAN#69

RP-151372: Motivation for Rel-13 LTE and WLAN Aggregation Using Bearer Switch and IP based Tunneling

WHY A LTE WLAN AGGREGATION SOLUTION?

- LTE WLAN aggregation can provide means for:
  - increased throughput/capacity without additional licensed spectrum expense;
  - Seamless user experience on licensed and unlicensed spectrum.

- WBA indicated to 3GPP (LAA-15005) that from a marketing perspective a successful solution for LTE WLAN aggregation shall fulfill three criteria:
  1. ***limited terminal impact***; it shall be possible for existent generation of UEs to be upgraded through simple software/firmware updates
  2. ***to be able to be used over multiple WLAN deployments***, enabling MNOs to seamlessly integrate with fixed WLAN partners
  3. ***limited impact on the eNB***.

WHY BEARER SWITCH?

- In dense WLAN deployments average number of users per WLAN channel is typically greater than 50 (eg. at Chicago O'Hare International Airport, public WLAN deployment currently support more than 100 users per WLAN channel)➔ the large number of users associated with a WLAN AP, creates the diversity that allows maximizing the resource utilization of the access while maintaining the traffic granularity at a "bearer" level. ***There is no significant benefit in splitting the traffic of a bearer over two accesses.***
- A typical eNB processes a large enough number of PDCP contexts at a moment => allocating data over different accesses at a finer level of granularity than a PDCP entity has only a minimal impact in improving capacity over the aggregated access
- When both accesses (cellular and WLAN) accommodate similar throughput IP flow based aggregation over both accesses can be used as a solution;
- When the accesses have very different transmission characteristics, per packet aggregation is not desirable: it will have a detrimental impact on the application performance as well as on the buffering requirements both in the network as well as on the terminal (if packet reordering is needed);
  - [1] RFC 2991
  - [2] draft---ietf---mip4---multiple---tunnel---support---09 (page 14)
- It is expected that in typical usage the throughput provided by WLAN to exceed the throughput provided by the cellular coverage by an order of magnitude at least;

WHY IP TUNNELING TRANSPORT OVER WLAN?

- ***The solution shall be able to be used over multiple WLAN deployments***, enabling MNOs to seamlessly integrate with fixed WLAN partners;

- There are several managed WLAN deployments in the field, based on various tunneling protocols between WLAN APs and WLAN Gateway/Controller with different mobility protocols, (both L2 and L3 mobility);

- ***An L3/L4 tunneling scheme over WLAN access allows the transport to be agnostic to the current WLAN deployment.***
- ***An IPSec based end-to-end encryption between UE and eNB over WLAN allows the data traffic to be exchanged secure and agnostic to the current WLAN deployment.***

DRAWBACKS OF A SOLUTION BASED ON "BEARER SPLIT"

- **SCHEDULER**
  - Inefficient use of limited resources (eg. if MeNB operates on a 20MHz bandwidth there are only 100 users that may be serviced each ms) → ***users with poor and no WLAN coverage have to compete for MeNB resources with the ones having good WLAN coverage***
  - "per packet" scheduling for QCI=1 bearer may create large number of out of order packets (50% of the packets) for a typical average HARQ retransmission of 4 and an equal split over both accesses → ***voice traffic shall not use bearer split***
- **UE**
  - All the received DL packet over WLAN must be forwarded to the cellular modem for PDCP processing including reordering
  - All the UL packets that are to be sent over WLAN must first go through the PDCP processing in the cellular modem before being packetized for the WLAN access.
  - Traffic burstiness on the DL as the cellular acts as a regulator of the WLAN link traffic.
- **MeNB**
  - Complex signaling between the egress X2 interface and egress cellular interface and the ingress S1 interface. The signaling is in the order of O(N) where N is the number of packet to be processed in the Downlink.
  - High buffer requirements for reordering buffer
  - Unnecessary traffic burstiness on the UL traffic

R2-151484: Traffic Steering Options for Cellular – WLAN RAN Interworking with Analysis

IMPACTS OF A SOLUTION BASED ON BEARER SWITCH AND E2E IPSEC TUNNELING

- **MeNB:**
  - All the data packets processed over WLAN are encrypted using IPSec; already both S1 and X2 packets data packets use IPSec encryption;
  - No complex scheduler required; Simplified management of the resources using the licensed spectrum as users with poor coverage do not have to compete for MeNB resources with users under good WLAN coverage
  - No re-ordering buffer required.

- **WLAN**
  - No impact and no extra requirement on the type of WLAN deployment.

- **UE**
  - All the IP data packets over WLAN are encrypted/decrypted using IPSec;
  - IPSec is already the default encryption protocol used in the UE for the traffic over WLAN;
  - No reorder buffer required for the DL traffic as all the packets of the same IP flow use the same access;
  - No extra burstiness introduced by the use of the heterogeneous access;
  - No changes required in the architecture of a terminal device.

Broadcom Corp. recommends the adoption of a solution with minimal impacts on the terminal and WLAN infrastructure for the LTE- WLAN aggregation in Release 13 as described in RP-151370.

Thank You!