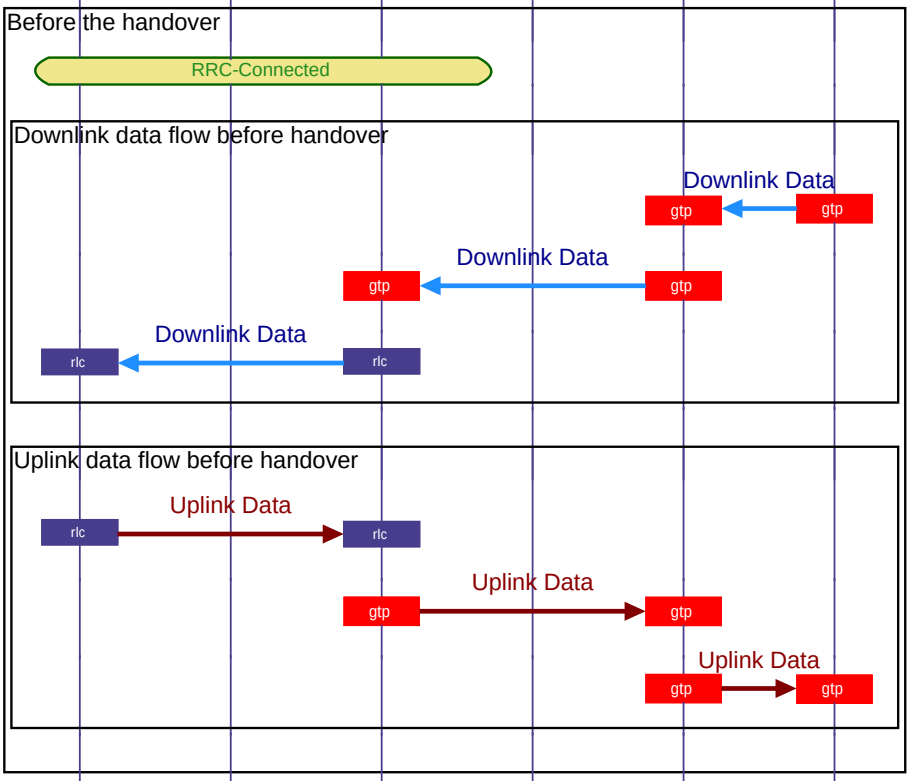
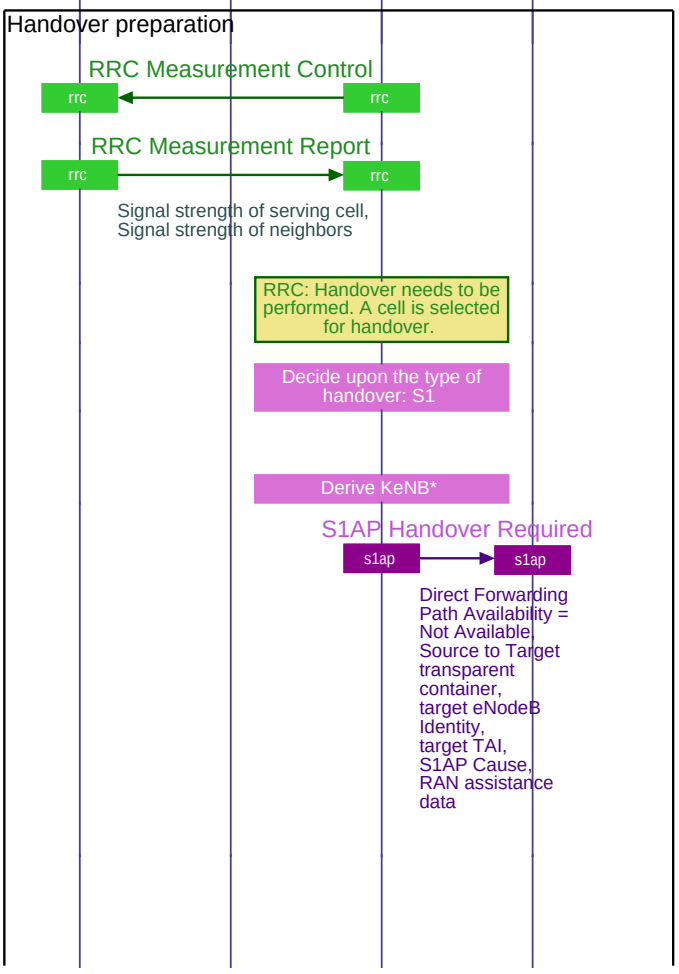
UE is handed over using an S1 handover if the X2 interface is not available between the source and target eNodeB.



The UE and Source eNodeB are in RRC Connected state.

Downlink data is flowing from the SGW to the UE via the Source eNodeB.

Uplink data is flowing from the UE to the SGW via the Source eNodeB.



The network sets the measurement thresholds for sending measurement reports.

Neighboring cell signal quality is now better than the serving cell.

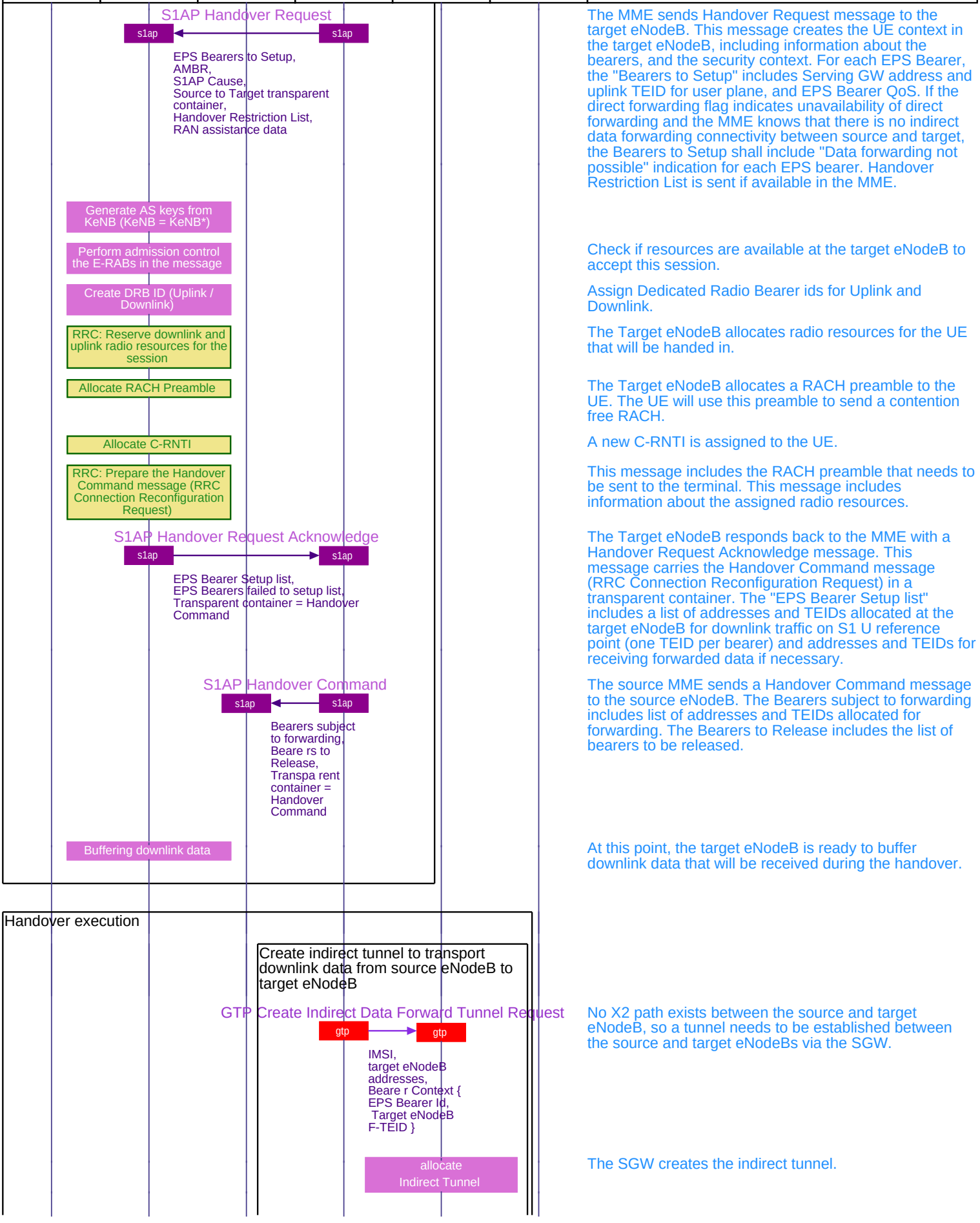
The RRC uses the latest measurement to decide if a handover is needed to another cell. The target cell is selected. The eNodeB for the target cell is identified.

The source eNodeB decides to initiate an S1-based handover to the target eNodeB as it does not have an X2 interface with the target eNodeB. (The S1 handover can also be triggered if the X2 handover had failed.)

The source eNodeB sends a "Handover Required" message to the MME. The source eNodeB indicates which bearers are subject to data forwarding. The X2 interface is not available, direct forwarding is not an option. The data will need to be tunneled via the SGW. The target TAI is sent to MME to facilitate the selection of a suitable target MME.

LTE S1 Handover (S1 Handover)

LTE Mobile	eNodeB Network		Core Network		
UE	Target eNodeB	Source eNodeB	MME	SGW	PGW



The MME sends Handover Request message to the target eNodeB. This message creates the UE context in the target eNodeB, including information about the bearers, and the security context. For each EPS Bearer, the "Bearers to Setup" includes Serving GW address and uplink TEID for user plane, and EPS Bearer QoS. If the direct forwarding flag indicates unavailability of direct forwarding and the MME knows that there is no indirect data forwarding connectivity between source and target, the Bearers to Setup shall include "Data forwarding not possible" indication for each EPS bearer. Handover Restriction List is sent if available in the MME.

Check if resources are available at the target eNodeB to accept this session.

Assign Dedicated Radio Bearer ids for Uplink and Downlink.

The Target eNodeB allocates radio resources for the UE that will be handed in.

The Target eNodeB allocates a RACH preamble to the UE. The UE will use this preamble to send a contention free RACH.

A new C-RNTI is assigned to the UE.

This message includes the RACH preamble that needs to be sent to the terminal. This message includes information about the assigned radio resources.

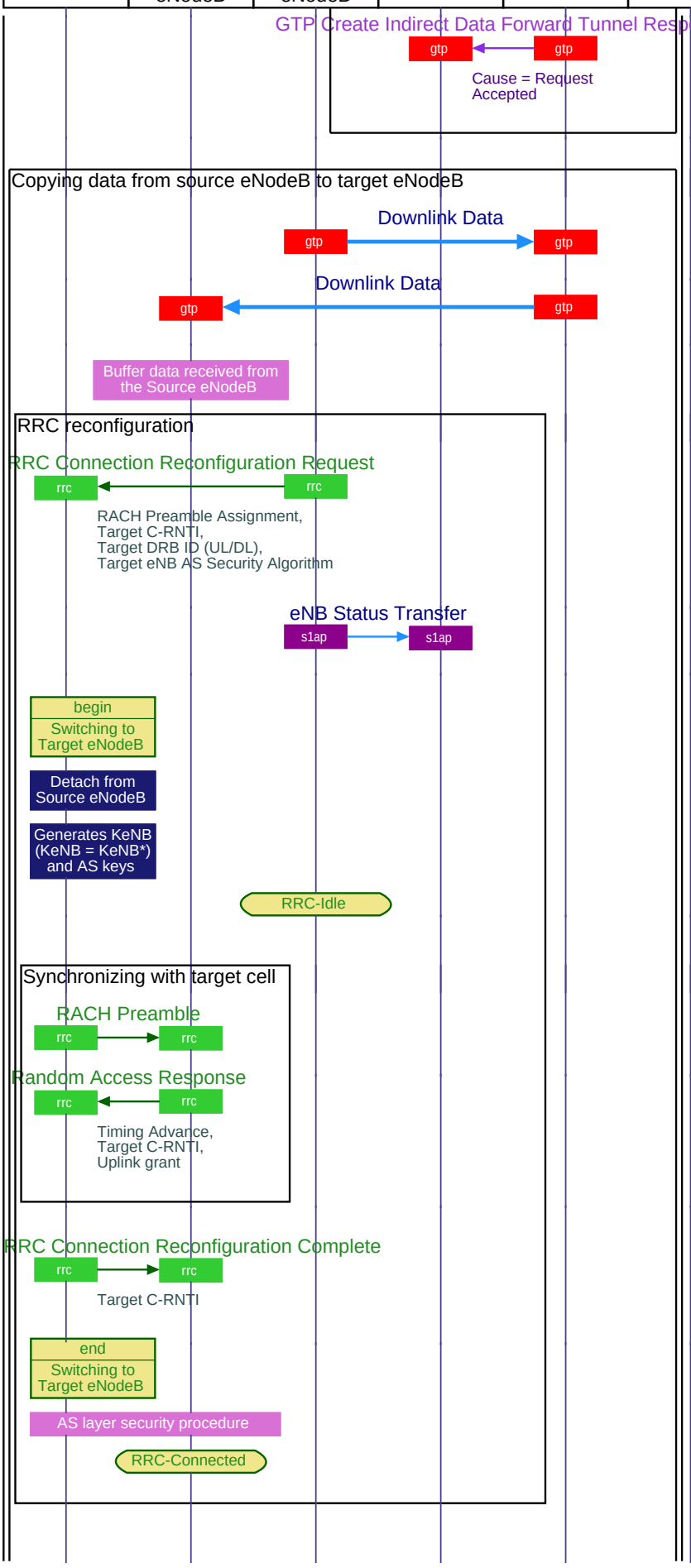
The Target eNodeB responds back to the MME with a Handover Request Acknowledge message. This message carries the Handover Command message (RRC Connection Reconfiguration Request) in a transparent container. The "EPS Bearer Setup list" includes a list of addresses and TEIDs allocated at the target eNodeB for downlink traffic on S1 U reference point (one TEID per bearer) and addresses and TEIDs for receiving forwarded data if necessary.

The source MME sends a Handover Command message to the source eNodeB. The Bearers subject to forwarding includes list of addresses and TEIDs allocated for forwarding. The Bearers to Release includes the list of bearers to be released.

At this point, the target eNodeB is ready to buffer downlink data that will be received during the handover.

No X2 path exists between the source and target eNodeB, so a tunnel needs to be established between the source and target eNodeBs via the SGW.

The SGW creates the indirect tunnel.



SGW replies back to the MME.

The downlink data is transported from the Source eNodeB to the Target eNodeB via the just established indirect tunnel.

The data cannot be sent to the target until the RRC reconfiguration is completed.

The Source eNodeB sends a handover command to the UE. The message contains a new C-RNTI and new DRB IDs. A RACH preamble is also included for contention free RACH access. Upon reception of this message the UE will remove any EPS bearers for which it did not receive the corresponding EPS radio bearers in the target cell.

The source eNodeB sends the eNodeB Status Transfer message to the target eNodeB via the MME(s) to convey the PDCP and HFN status of the E-RABs for which PDCP status preservation applies.

Meanwhile, the UE has received the handover command and it is switching to the new target cell.

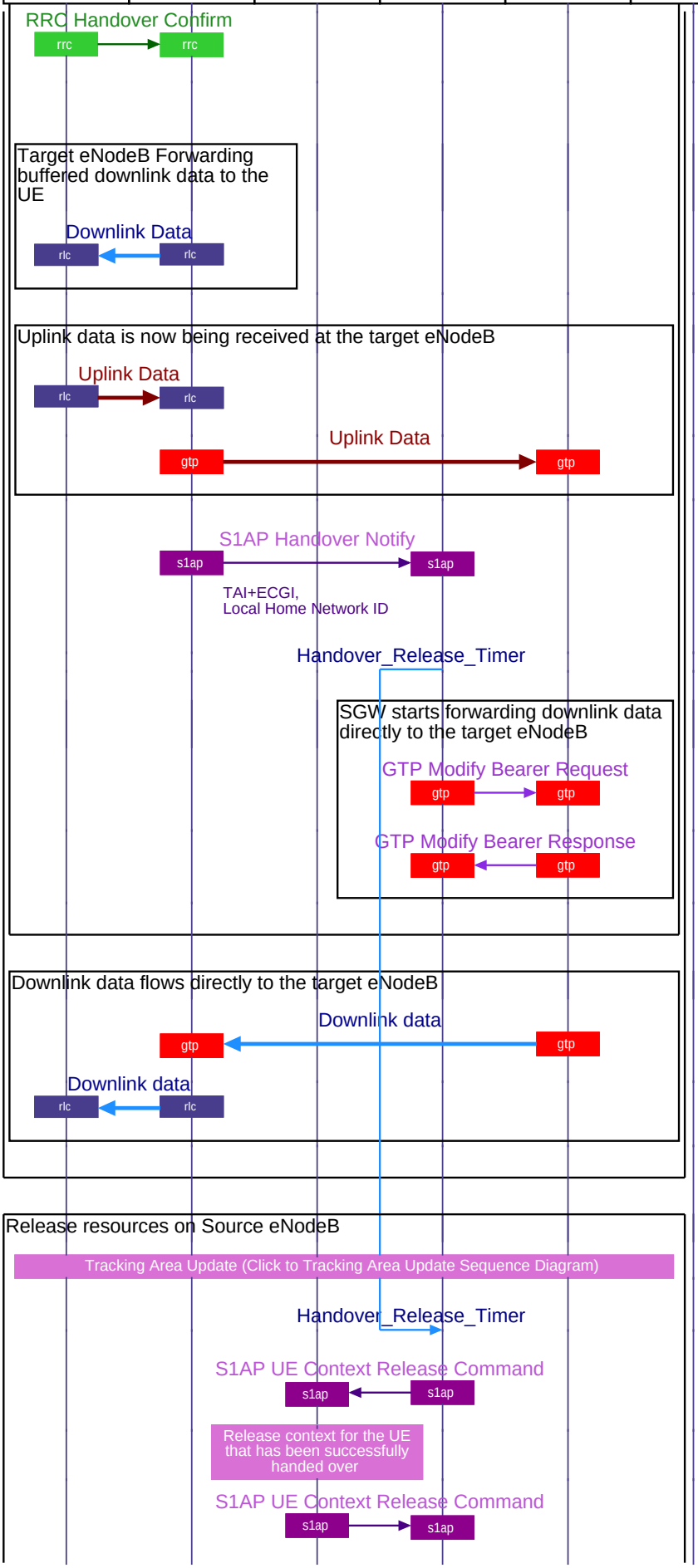
At this point, the UE has detached from the source eNodeB but is still not communicating with the target eNodeB. The UE is in the RRC-Idle state.

UE uses the preamble assigned in the handover command to send a RACH to the target eNodeB.

The target eNodeB accepts the request and responds back with a timing adjustment and an uplink resource grant.

The UE uses the assigned resources to transmit the Handover Confirm message (RRC Connection Reconfiguration Complete).

The UE is not connected to the Target eNodeB. Thus it transitions to the RRC-Connected state.



After the UE has successfully synchronized to the target cell, it sends a Handover Confirm message to the target eNodeB. Downlink packets forwarded from the source eNodeB can be sent to the UE. Also, uplink packets can be sent from the UE, which are forwarded to the target Serving GW and on to the PDN GW.

The buffered downlink data is sent to the terminal.

Uplink data is now being received from the terminal.

The uplink data is now flowing directly from the Target eNodeB to the SGW.

The target eNodeB sends a Handover Notify message to the target MME.

Handover is successful. Start a timer for a delayed resource cleanup.

Handover has been successful. So the Downlink path can be switched from the Source eNodeB to the Target eNodeB.

SGW has switched the path to the Target eNodeB, so the downlink data is directly delivered to the target eNodeB.

The UE may perform a tracing area update due to cell change.

Resource release timer has expired. Now resources can be cleaned up at the source eNodeB.

Initiate resource release on the Source eNodeB.