32.9   MOBILITY ROBUSTNESS OPTIMISATION

★   Mobility robustness optimisation was first introduced within the release 9 version of the 3GPP specifications. The inter-system component was added by the release 10 version of the specifications

★   Mobility robustness optimisation provides support for detecting and helping to correct:

   o   connection failures caused by intra-LTE mobility

   o   unnecessary inter-system handovers to other radio access technologies

★   Figure 320 illustrates the set of 3 intra-LTE mobility scenarios identified for mobility robustness optimisation:

   o   handover occurs too late: radio link failure occurs in the source cell before a handover was initiated, and the UE attempts to re-establish its radio link in another cell. Alternatively, radio link failure occurs in the source cell during the handover procedure, and the UE attempts to re-establish its radio link in the target cell

   o   handover occurs too early: radio link failure occurs in the target cell after a handover has been completed, and the UE attempts to re-establish its radio link in the source cell. Alternatively, radio link failure occurs in the target cell during the handover procedure, and the UE attempts to re-establish its radio link in the source cell

   o   handover to the wrong cell: radio link failure occurs in the target cell after a handover has been completed, and the UE attempts to re-establish its radio link in a cell which is not the source cell nor the target cell. Alternatively, radio link failure occurs in the target cell during the handover procedure, and the UE attempts to re-establish its radio link in a cell which is not the source cell nor the target cell
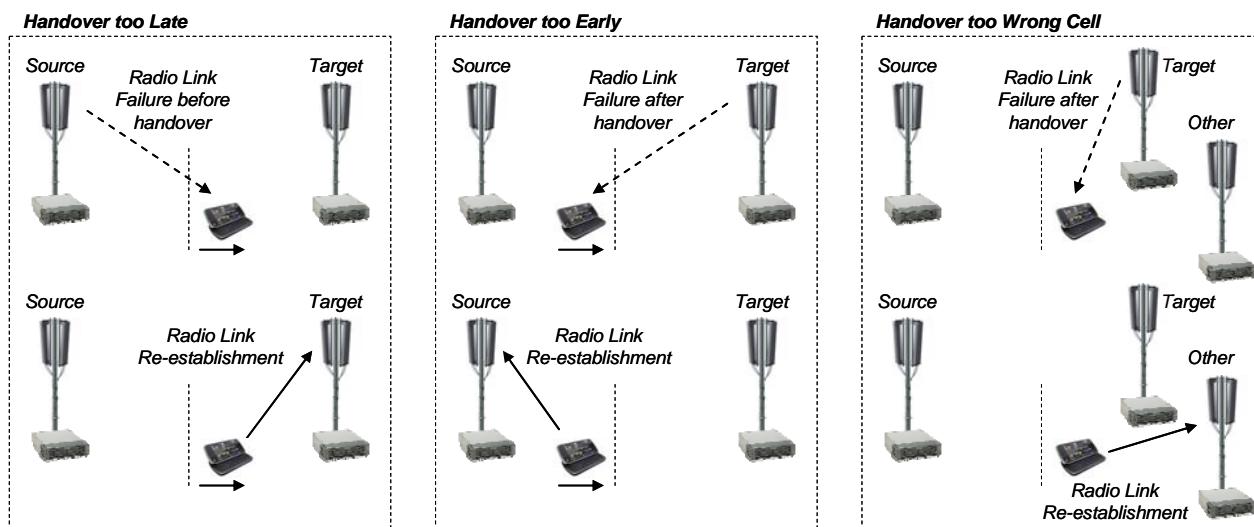

Figure 320 – Handovers too late, too early and to the wrong cell

★   Each of the above failure scenarios can be detected after an RRC connection re-establishment, or after an RRC connection setup. UE are able to include a flag within either the RRC Connection Re-establishment Complete message, or the RRC Connection Setup Complete message to indicate that radio link failure information is available for reporting (UE can also include the same flag within an RRC Connection Reconfiguration Complete message)

★   After detecting this flag, the eNode B can request the UE to report the radio link failure information using a UE Information Request message. The UE provides its report using a UE Information Response message. This signalling is illustrated in Figure 321

★   If RRC connection re-establishment has been completed at a cell which does not belong to the source eNode B then the eNode B which has received the radio link failure information can signal the information to the source eNode B. This is done using the X2-AP: Radio Link Failure Indication message

★   The content of the X2-AP: Radio Link Failure Indication message is presented in Table 365

★   The Failure Cell Physical layer Cell Identity (PCI) indicates the PCI of the cell to which the UE was connected when the radio link failure occurred. This information is extracted from the RRC Connection Re-establishment Request message from the UE. The Failure Cell PCI information element is not used if the UE used the RRC connection setup procedure rather than the RRC connection re-establishment procedure

★   The Re-establishment ECGI provides the identity of the cell where the RRC connection re-establishment procedure was completed, i.e. the identity of one of the cells belonging to the target eNode B shown in Figure 321. This information element is not used if the UE used the RRC connection setup procedure rather than the RRC connection re-establishment procedure
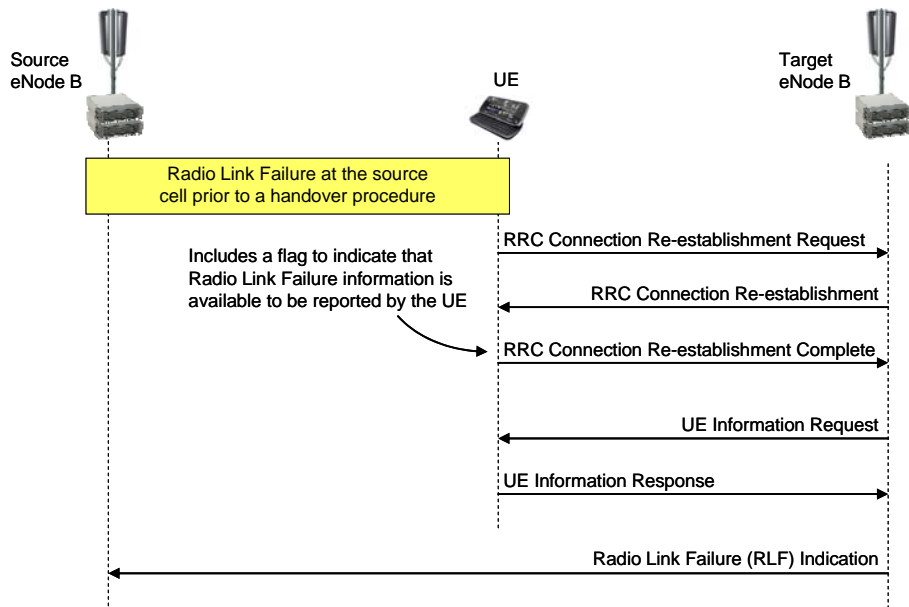
Figure 321 – Reporting of radio link failure information (too late handover)

Information Elements		
Failure Cell PCI		
Re-establishment EUTRAN Cell Global Identity (ECGI)		
C-RNTI		
ShortMAC-I		
UE RLF Report Container	Measurement Result from Last Serving Cell	RSRP
		RSRQ
	Measurement Result from Neighbouring Cells	Measurement Result List from EUTRAN
		Measurement Result List from UTRAN
		Measurement Result List from GERAN
		Measurement Result List from CDMA2000
	Location Information	
	Failed PCell Id	CHOICE
		CGI
		PCI & ARFCN
	Re-establishment Cell Id	CGI
	Time Connection Failure	
	Connection Failure Type	
	Previous PCell Id	CGI
RRC Connection Setup Indicator		

Table 365 – Content of X2-AP: Radio Link Failure (RLF) Indication message

★ The C-RNTI defines the identity of the UE allocated by the source cell prior to the radio link failure. This information is extracted from the RRC Connection Re-establishment Request message from the UE. The C-RNTI information element is not used if the UE used the RRC connection setup procedure rather than the RRC connection re-establishment procedure

★ The ShortMAC-I provides the 16 least significant bits of the MAC-I calculated using the security configuration belonging to the source cell. This ShortMAC-I information is extracted from the RRC Connection Re-establishment Request message from the UE. The MAC-I information element is not used if the UE used the RRC connection setup procedure rather than the RRC connection re-establishment procedure

★ The UE Radio Link Failure (RLF) Container is extracted from the UE Information Response message. It includes RSRP and optionally, RSRQ measurements from the source cell, i.e. measured from the cell where radio link failure was experienced. It also includes optional measurement results from neighbouring cells. These neighbouring cells can belong to E-UTRAN, UTRAN, GERAN or CDMA2000

★ The remaining sections of the UE RLF Report Container were introduced by the release 10 version of the 3GPP specifications and are all optional

★ The Location Information allows the UE to report the geographic location where the radio link failure was experienced. It relies upon the UE having knowledge of its location

★ The Failed Primary Cell Identity defines the primary cell in which radio link failure was detected or the target primary cell of the failed handover. The cell identity can be reported using either the Cell Global Identity (CGI) or a combination of PCI and ARFCN

★ The Re-establishment Cell Identity defines the CGI of the cell where connection re-establishment was attempted after the radio link failure

★ The Time Connection Failure defines the time interval between the handover initialisation and the radio link failure. This variable can be signalled using values within the range 0 to 1023. The actual value = signalled value × 100 ms. The maximum value of 102.3 seconds is interpreted as meaning 102.3, or more seconds

★ The Connection Failure Type indicates whether the failure was a radio link failure or a handover failure

★ The Previous Primary Cell Identity defines the source primary cell of the last handover

★ The RRC Connection Setup Indicator is a flag which is included if the UE provided the radio link failure report after an RRC connection setup procedure rather than an RRC connection re-establishment procedure. Inclusion of this flag means that the eNode B receiving the X2-AP: Radio Link Failure Indication message should ignore the Failure Cell PCI, Re-establishment ECGI, C-RNTI and ShortMAC-I information elements

★ Having received the X2-AP: Radio Link Failure Indication message, the source eNode B can use the content to adjust its handover triggering configuration

★ In the case of a 'too early handover', the UE attempts to re-establish its connection with the source cell so radio link failure information is reported directly to the source eNode B. In this case, the target eNode B can provide the source eNode B with an X2-AP: Handover Report message. The content of this message is presented in Table 366

Information Elements
Handover Report Type
Handover Cause
Source Cell ECGI
Failure Cell ECGI
Re-establishment Cell ECGI

Table 366 – Content of X2-AP: Handover Report message

★ The Handover Report Type can be signalled with values of either 'Handover Too Early' or 'Handover to Wrong Cell', i.e. this message can also be used for the 'handover to wrong cell' scenario

★ The Handover Cause specifies the reason for the handover, e.g. 'Handover Desirable for Radio Reasons'. This reflects the cause value within the X2-AP: Handover Request message sent from the source cell during the handover procedure

★ The source and failure cells are identified by their E-UTRAN Cell Global Identities (ECGI)

★ The Re-establishment Cell ECGI is included if the Handover Report Type is set to'Handover to Wrong Cell'

★ Figure 322 illustrates example signalling for the 'Handover to Wrong Cell' scenario. In this case, the third eNode B provides the target eNode B with an X2-AP: Radio Link Failure Indication message, while the target eNode B provides the source eNode B with an X2-AP: Handover Report message

★ The 'Handover to Wrong Cell' scenario does not always have to involve 3 eNode B. For example, after radio link failure the UE could attempt RRC connection re-establishment at a second cell belonging to the target eNode B

★ Having received the X2-AP: Handover Report message, the source eNode B can use the content to adjust its handover triggering configuration

★ The second objective of mobility robustness optimisation is to detect and help to correct unnecessary inter-system handovers. In general, UE should be kept on the LTE network unless congestion is detected and load balancing is triggered, or the UE is moving out of LTE coverage. Inter-system handovers generate network signalling load and could result in reduced end-user experience, e.g. lower throughputs on a GERAN network

★ Non-optimal handover triggering parameters can lead to coverage based inter-system handovers while LTE coverage remains relatively good. This represents a too early inter-system handover without radio link failure on the target radio access network. The release 10 version of the 3GPP specifications allows this scenario to be detected and reported back to the LTE network

★ When completing an inter-system handover towards UTRAN, the eNode B can use the S1-AP: Handover Required message to include 'IRAT Measurement Configuration' information within the 'Source RNC to Target RNC Transparent Container'. Similar information can also be included when completing an inter-system handover towards GERAN