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Handover Principles and UE Capabilities

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Document for Discussion and Decision

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General Handover Principles for EUTRA

- UE assisted network controlled handover is proposed as the primary method
  - Other alternatives can be considered for e.g. the case that current connection becomes unsustainable, while NW fails to issue a handover command
- Macro diversity support (fast cell selection, bi-casting) complicates network architecture, radio interface protocols and L1 timing (syncronization) design
  - Soft handover or other macro diversity features (fast cell selection, bi-casting) should be carefully assessed in RAN1
  - Supported only if essential to meet the requirements
- Handover decision primarily based on
  - Measurement results reported by the UE
  - Measurements in the network
  - Cell-specific parameters
- Possible handover reasons other than radio conditions
  - Change of service or service mixture
  - Load control
- Types of Handovers
  - EUTRAN intra and inter-frequency hard handover
  - Inter-RAT Handovers
    - To/from UTRA
    - To/from GERAN

Principles for Handover-Related Measurements

- Intra-frequency handovers
  - Intra-frequency measurements simultaneously with data reception
  - Synchronization to the neighbor cells for measurement
    - Details such as synchronization, pilot structures and the required neighbor cell information are FFS
- Inter-frequency handovers within EUTRAN
  - UE may need to measure inter-frequency cells to prepare for inter-frequency handover
  - In such a case,
    - EUTRAN provides a list of inter-frequency neighbour cells to measure
    - Idle periods are provided by packet scheduling
    - UE performs measurements by using idle periods created by scheduler (both DL and UL)
- Close co-operation between different RAN WGs is required in order to optimize signaling and UE measurement performance

Measurements for Inter-RAT Handovers

- Necessary to be able to perform inter-RAT handover without simultaneous use of two receiver chains
- Handovers from EUTRAN
  - UE needs to measure inter-RAT neighbours
  - In such a case,
    - EUTRAN provides a list of inter-RAT neighbours to measure
    - Idle periods are provided by packet scheduling
  - UE performs measurements using idle periods created by the scheduler (both DL and UL)
- Handovers to EUTRAN
  - From UTRAN, a UE can perform measurements by using idle periods created by compressed mode / higher layer scheduling in DL and possibly in UL
    - FFS whether modifications are needed in UTRAN specifications to support this
  - From GERAN, measurements are done in a same way as for GERAN to UTRAN handovers
    - FFS whether modifications are needed in GERAN specifications to support this
  - Strategy needed for the case whether both UTRAN and EUTRAN should be measured.
    - Very limited system parameter provisioning from GERAN (as is the case with UTRAN).

Proposed Groups to Address E-UTRA Handover-Related Requirements

- RRM concept and strategies (RAN1-4)
  - Overall RRM concept
  - System information provision
- Cell identification and neighbour cell level measurements
  - Cell search procedure and measurement quantity: RAN1
  - UE performance requirements and measurement strategies: RAN4
- Handover delay
  - Signalling: RAN2, RAN3
  - UE and UTRAN procedure delays: RAN2, RAN3, RAN4
- Interruption time
  - UE delays: RAN2 and RAN4
  - NW delays: RAN3 and RAN4
- Cell re-selection principles
  - Signalling aspects RAN2
  - Idle mode Requirements RAN4

UE capabilities (within EUTRAN and Multi-RAT cases)

- In TR 25.913 v.2.0.0 it is stated:
  - *"The number of options shall be minimized. Sets of options shall be realizable in terms of separate distinct UE "types/capabilities". Different UE "types/capabilities" shall be used to capture different complexity vs. performance trade-offs, e.g. for the impact of multiple antennas."*
  - *There shall be no redundant or duplicate specifications of mandatory features, or for accomplishing the same task"*
  - *"UE complexity in terms of supporting multi-RAT (GERAN/UTRA/E-UTRA) should be considered when considering the complexity of E-UTRA features"*
- For EUTRAN UE capabilities this implies:
  - Multiband support needs a generic solution (future proof, applicable for all band combinations)
- For Multi-RAT UE capabilities this implies:
  - Interworking between E-UTRA and UTRA solved in a generic fashion
    - Solution works regardless of frequency band combinations (simple, future-proof solution)
    - No simultaneous operation on multiple systems at the same time
    - Number of different Multi-RAT UE alternatives needs to be minimized
  - UE complexity should be considered when defining Multi-RAT UE capabilities

Issues with Dual/Multi-Connection UE approach

- In the future it is even more important than today to ensure a possibility for various band allocations and UL/DL pairings
  - This should be carefully considered in the concept development
- Interworking based on dual/multi-connection UE:s is not a generic solution, since severe interference cases occur especially between the IMT-2000 bands in 1.8-2.1 GHz region and the 2.6 GHz bands.
  - UE internal interference issues -> filtering, and linearity problems.
  - **TX power reduction due to SAR limits** -> Integrated over all simultaneous transmitted signals. -> UL coverage dependent on the # of active transmitters
- Uncoordinated solution is not future-proof, as new frequency combinations may not be possible to support
  - Dual/multi connection UE approach would be frequency band dependent, i.e. not a generic solution, and hence it would not fulfil the “single solution requirement.”
- Interworking based on dual/multi-connection UEs introduces unnecessary complexity both in the system and in UE
- Parallel solutions/options to same problem leads to:
  - NW Complexity due to different solutions
    - RRM issues (Network coverage planning due to SAR limitations)
    - Possible impacts to interfaces, complexity on network side due to parallel solutions
  - Multiple different terminal capabilities dependent on interworking solutions:
- Dual/multi-connection operation would lead into very complex network planning.
- Good co-operation and coordination is needed between different RAN WGs in order to optimise signalling based on realistic performance and complexity estimates

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Conclusions

- Primary proposed HO method: UE assisted network controlled handover
  - Other alternatives can be considered
- No soft handovers or other macro diversity features (FCS, bi-casting) unless essential to meet the TR requirements
- Measurements done using idle periods created by packet scheduler
- Dual/multi connection operation would lead into very complex network planning as the same frequencies could not be used for different systems
- Interworking based on dual/multi-connection UEs introduces unnecessary complexity both in the system and in the UE
- Close co-operation between RAN WGs is required in order to optimise signalling, performance and complexity issues