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DIRECTED HANDOVER MECHANISM FOR EFFECTIVE DOPPLER REDUCTION IN LTE CELLULAR TELEMETRY

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14. ABSTRACT Aeronautical mobile telemetry needs for providing communication to very high-speed test articles falls beyond the nominal operating envelope of cellular LTE systems. Laboratory experimentation on operational LTE networks demonstrates the limitations on LTE uplink and downlink separately, illustrating the limits of frequency offset compensation procedures typically encountered in commercial systems. To address the limitation, a test range telemetry cellular network is devised to provide coverage and supervised handover mechanisms that are directed by a centralized control entity designed to reduce maximum Doppler shift. The method to exercise directed handover is illustrated in this talk and the expected reduction in the apparent Doppler to a test article is demonstrated. The technique uses standard mechanisms for informing base stations of the channel conditions observed at the mobile, selection of the settings for triggering of handover events and the choice of desirable overall LTE parameters for test range applications. To make use of the base station's authority to make handover decisions a deviation from typical LTE procedures is needed and a description of the necessary interventions within the Radio Access Network are discussed. We describe the laboratory experiment setup used to verify the performance of handovers under conditions that can be encountered in the test range. The experiments provide us with guidance on designing the LTE radio access network and applying centralized control so as to stay within acceptable performance limits. A set of rules is deduced from these experimental observations, which are used for the near real-time control of a cellular telemetry network to allow use of LTE systems for AMT applications.				
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Directed Handover Mechanism for Effective Doppler Reduction in LTE Cellular Telemetry

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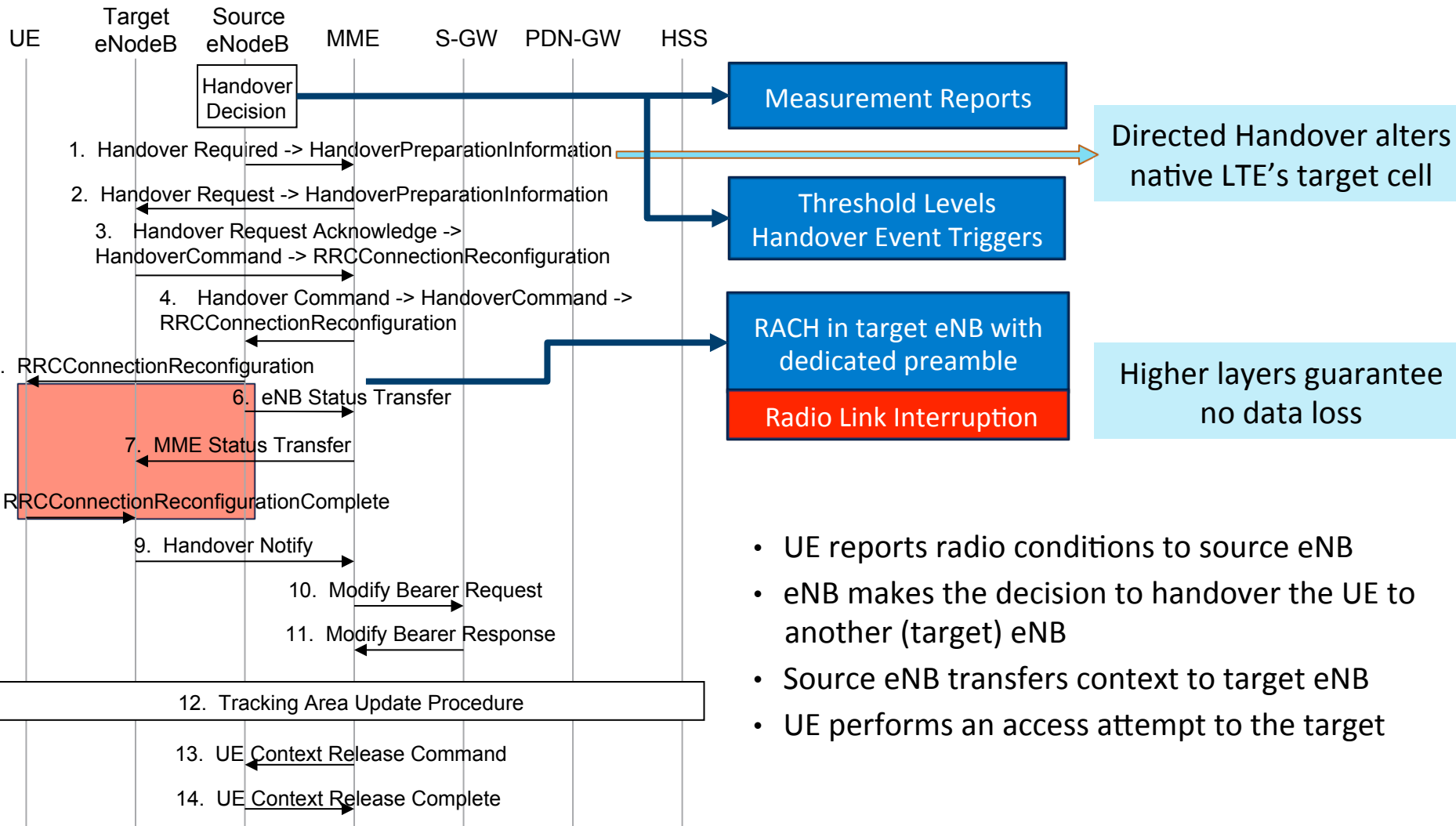
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Directed handover

- LTE is a data packet oriented air-interface. Handover mechanisms are standardized.
- Handover aims for providing an adaptive radio link between the mobile device (UE) and base stations while traversing the network coverage area.
- Native LTE handover criterion is radio link quality. Handover is network controlled
- Network is informed by UE of the radio channel conditions. Base station may decide to assign a new base station to that UE
- We can modify the Handover criterion without violating LTE standard (blind handover)
 - Blind Handovers are typically not implemented by vendors
- To satisfy the Cellular Range Telemetry needs we modify the criterion to be links with relatively low Doppler to allow LTE operation within its nominal envelope (maximum 350-500Km/hr)

S1 Native Handover Call Flow



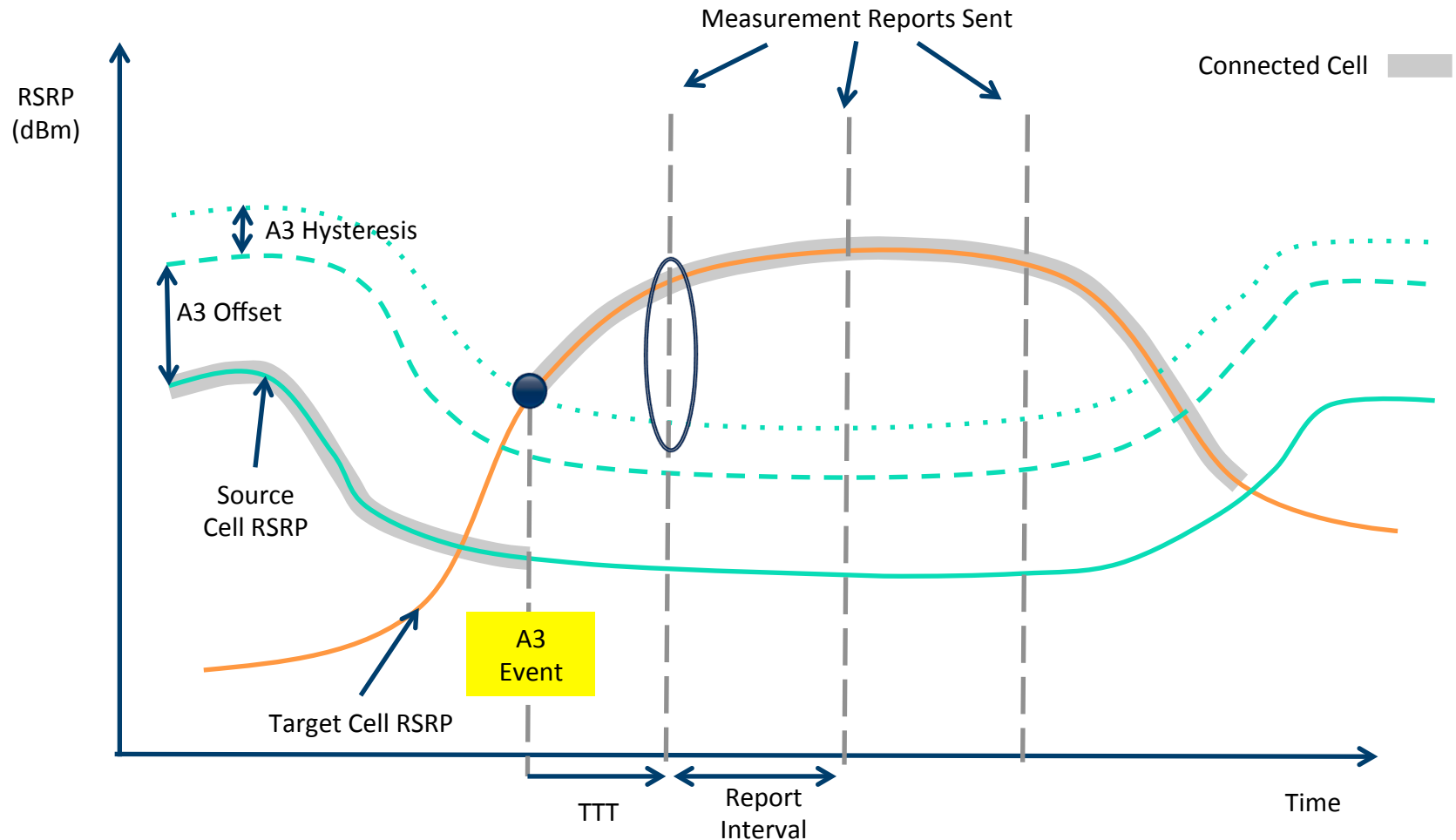
S1 Handover Call Flow

- UE reports radio conditions to source eNB
- eNB makes the decision to handover the UE to another (target) eNB
- Source eNB transfers context to target eNB
- UE performs an access attempt to the target

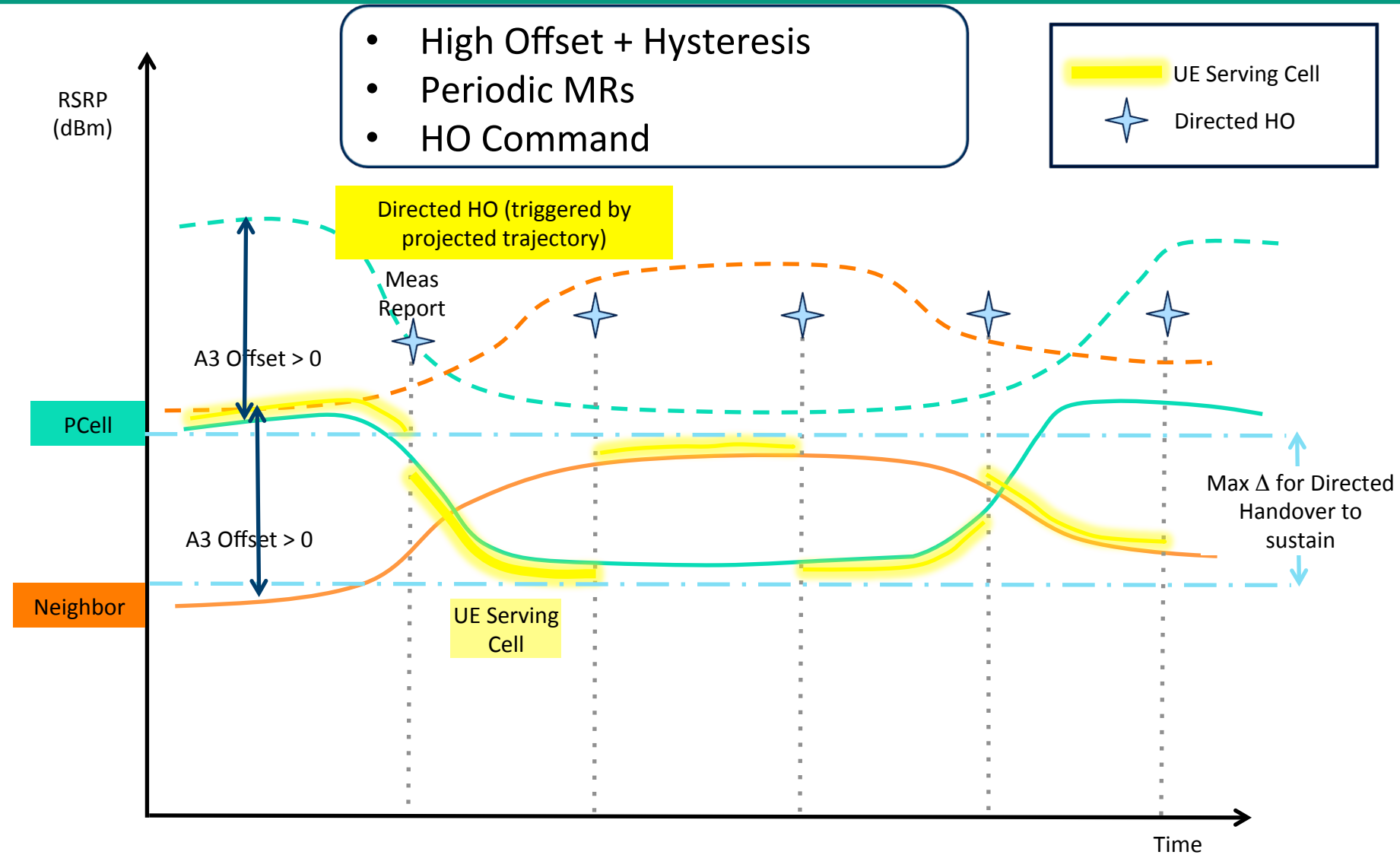
Native Handover: A3 Event

Entering Condition: $RSRP_{Target} > RSRP_{Serving} + A3_{Offset} + Hysteresis$

Leaving Condition: $RSRP_{Target} < RSRP_{Serving} + A3_{Offset} - Hysteresis$



Directed Handover

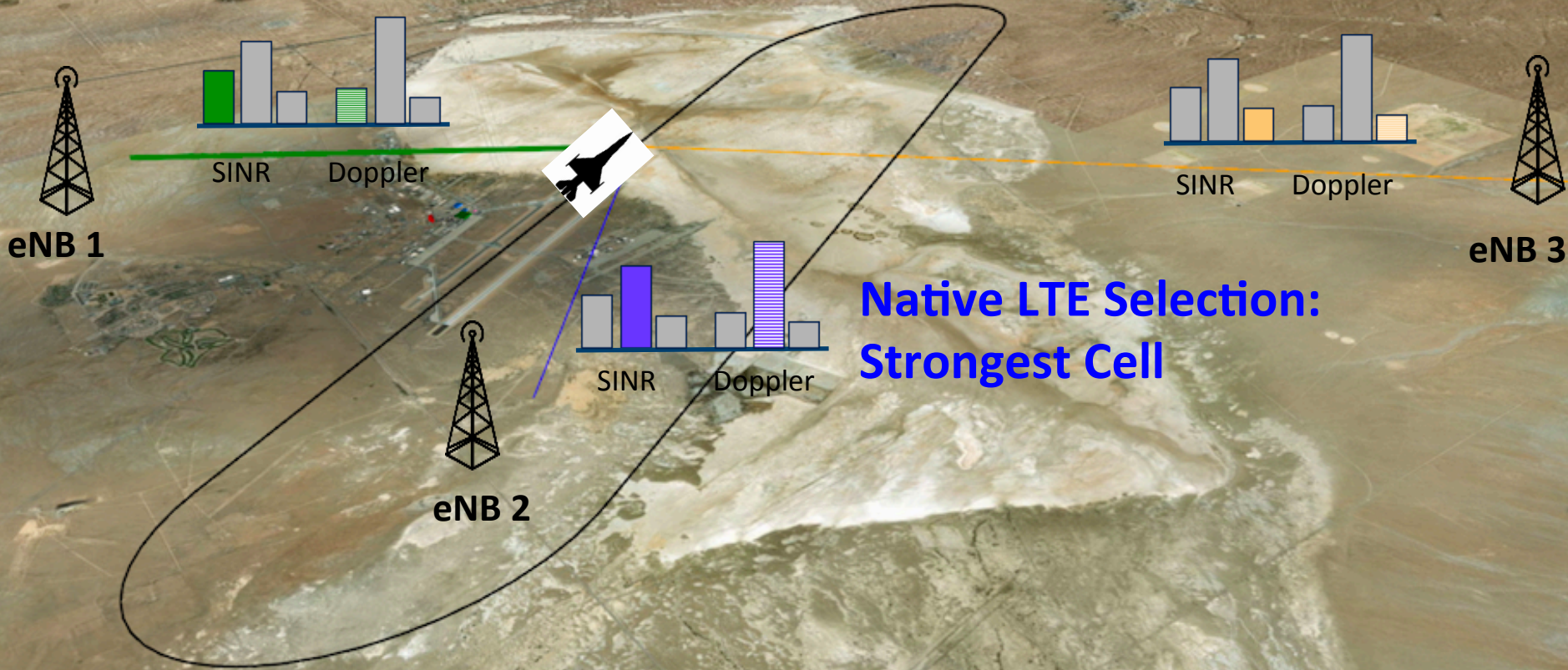


Problem Setup & Native LTE Operation

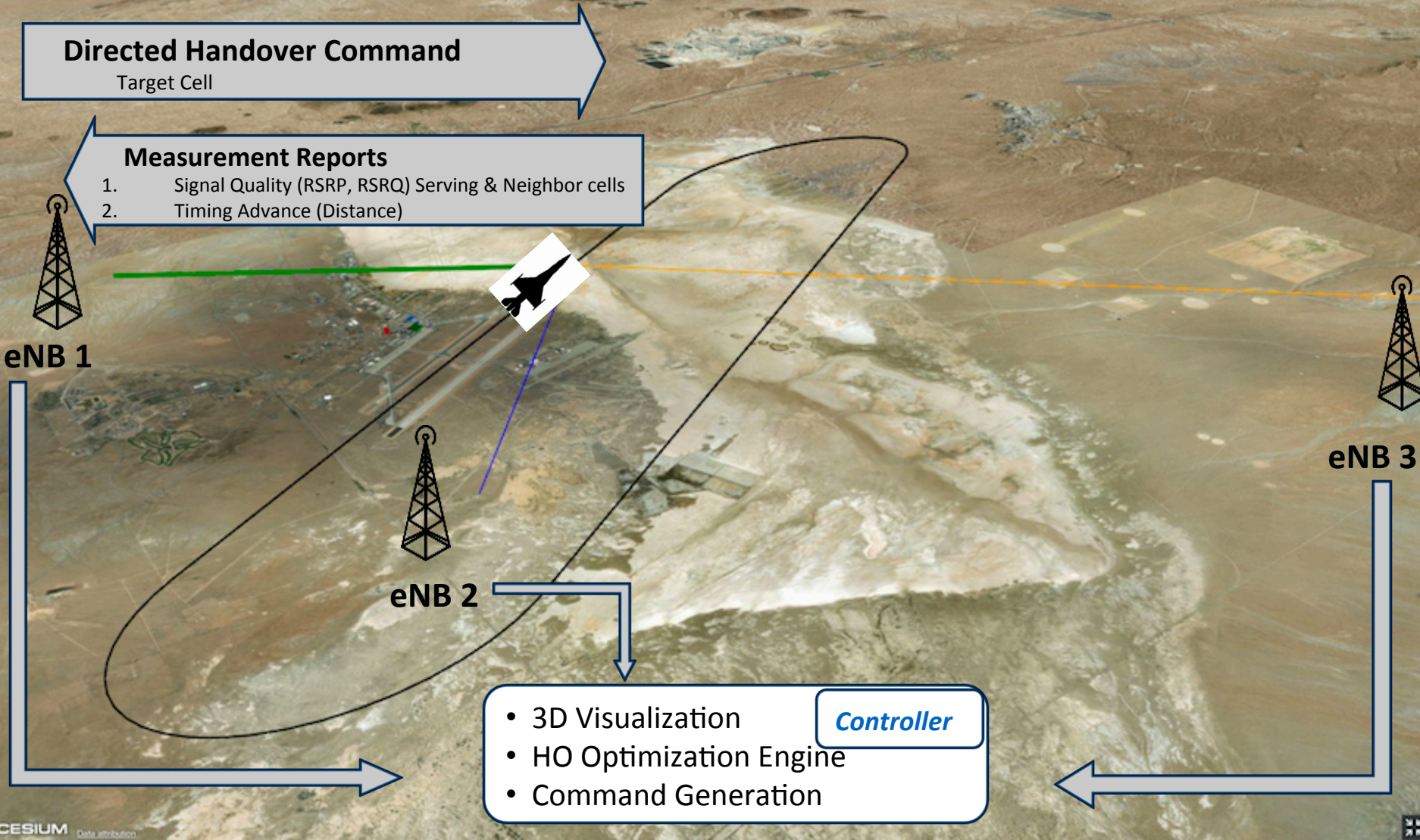


**CeRTN Selection:
Strong Cell with Low Doppler**

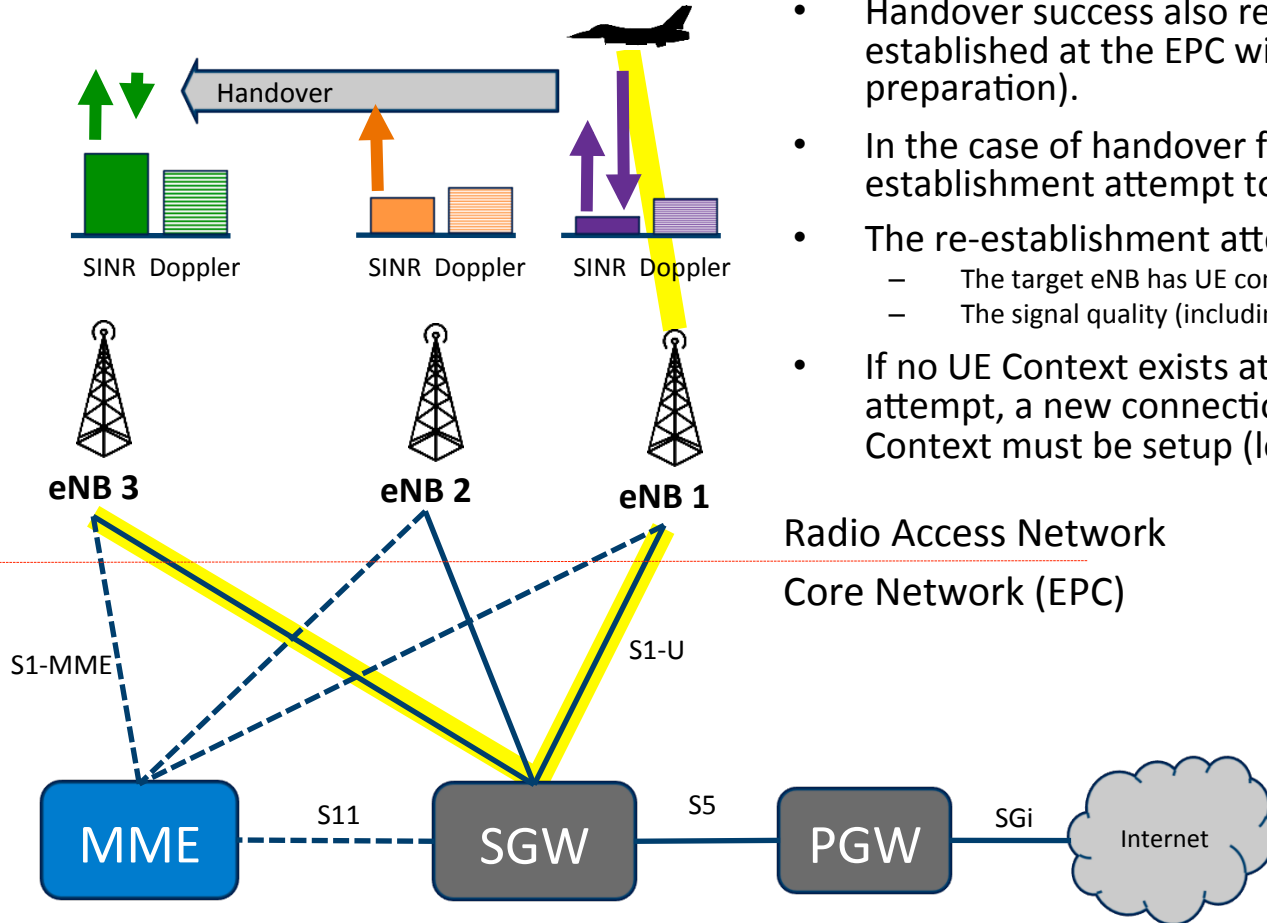
Lowest Doppler Cell



ICNC Operation: Directed Handovers



Connectivity During Handover



- TA detects the presence of multiple eNodeBs while connected to eNB1.
- Handover to an eNB will succeed if the corresponding SNR is adequate and the Doppler is reasonably low.
- Handover success also requires that UE Context has been established at the EPC with target eNB (handover preparation).
- In the case of handover failure, the TA will try to make a re-establishment attempt to the strongest eNB.
- The re-establishment attempt succeeds only if
 - The target eNB has UE context, AND
 - The signal quality (including Doppler) is adequate
- If no UE Context exists at the eNB during reconnection attempt, a new connection request is needed and new UE Context must be setup (longer process through the EPC).

Radio Access Network
Core Network (EPC)

Impact on Effective Doppler

- TA Oval trajectory: 20Km x 5Km
- Trajectory covered by 5 eNBs
- A hybrid Doppler strategy indicates a big reduction in the extreme Doppler experienced.
- Handover triggered by external controller
- Criteria to select Handover target can be adapted to optimize link quality, Doppler, or interference

