NOKIA

Nokia Networks

5G RAN Design Workshop:

A Novel State Model for 5G Radio Access Networks

Icaro Leonardo da Silva, Gunnar Mildh, Ericsson Research, Sweden
Mikko Säily, Sofonias Hailu, Nokia Bell Labs, Finland

ICC'16, 27th May 2016, Kuala Lumpur

© Nokia Solutions and Networks 2014

Outline and Scope

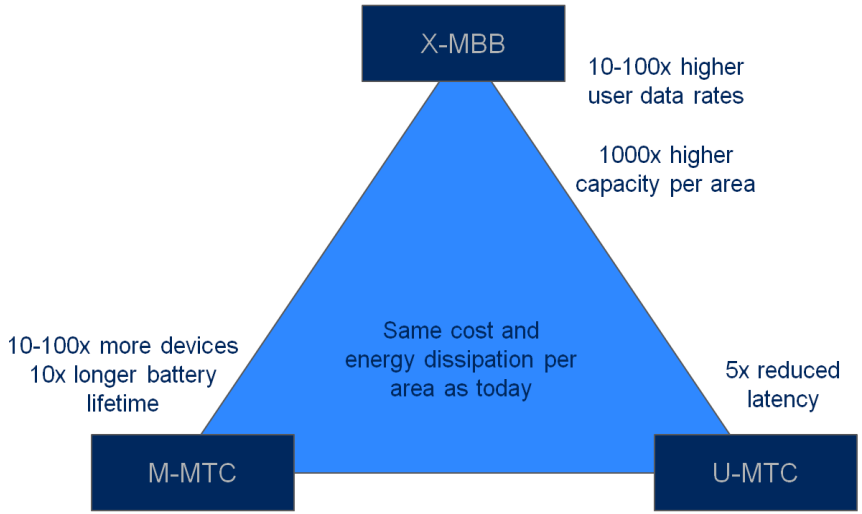
- Reasoning for a new state model in 5G
- Key characteristics of a new state
- State transitions in LTE and 5G and the new proposed model.
- Configurability of a new Connected Inactive state in 5G
- Conclusion

© Nokia Solutions and Networks 2014

Reasoning for a new RRC state model in 5G

RRC States are a solution to the system access, power saving and mobility optimization.

- **Mission critical U-MTC UE**
  - Transmits small packets that require ultra-low latency and/or high reliability.
- **Massive M-MTC UE**
  - wakes up seldom power saving mode to transmit and receive a small payload.
  - camping in low activity state, and sporadically transmits UL data and/or status reports with small payload to the network.
  - have periodic and/or sporadic DL small packet transmission.
  - are in connected state, and sporadically transmit UL data and/or status reports with small payload to the network.
- **Smartphones and consumer devices X-MBB UE**
  - have periodic and/or sporadic UL and/or DL small packet transmission and extreme data rates.
- **5G system access and requested services have different characteristics => Control of connectivity for future services needs to flexible and programmable.**



© Nokia Solutions and Networks 2014
NOKIA

Key Characteristics of the Proposed State in 5G, *RRC Connected Inactive*

- **Maintenance of context information** by the UE and the network when the UE moves from “RRC Connected” to “RRC Connected Inactive.”
- **Widely configurable DRX cycles** to support a wide diversity of services with different requirements in terms of power consumption and accessibility delays.
- **UE controlled mobility and RAN-based paging** with optimized state transitions for the case where the UE is semi-static i.e. the UE remains in the same location after inactivity timer expires. The concept of camping for Idle UEs is extended to the RRC Connected Inactive UEs.
- **Multi-RAT camping and access** where the evolution of LTE is tightly integrated to the 5G RAN.
- **Highly configurable procedures** that may possibly take into account known characteristics at the RAN level such as mobility pattern and traffic characteristics for the different services and performance requirements in terms of delay accessibility.

© Nokia Solutions and Networks 2014

5G RRC state management for *RRC Connected Inactive*

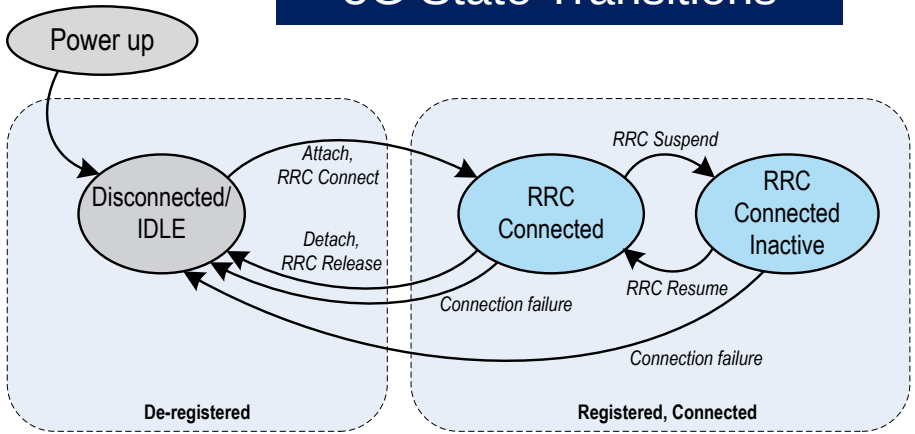
LTE States

UE status	Off	Attaching	Idle/ Registered	Connecting to EPC	Active
EMM	Deregistered		Registered		
ECM	Idle				Connected
RRC	Idle	Connected	Idle	Connected	
Mobility control	-	UE based	UE based	NW based	

5G States

UE status	Off	Attaching	Connected/ Inactive	Connected/ Active
MM*	Deregistered		Registered	
CM*	-	Connected		
RRC*	-	Connected	Inactive	Connected
Mobility control	-	UE based	UE based, NW assisted	NW based

5G State Transitions

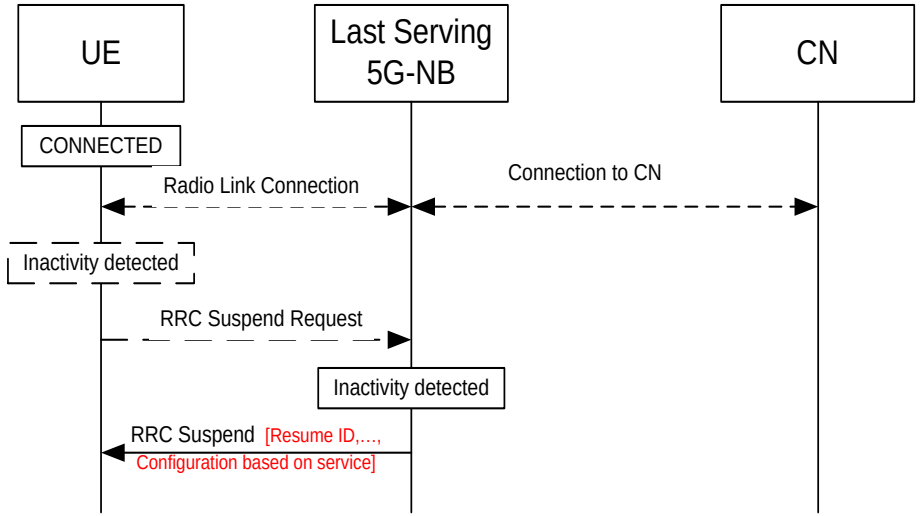


EPS Mobility Management (EMM)
EPS Connection Management (ECM)
Evolved Packet System (EPS)
Evolved Packet Core (EPC)

© Nokia Solutions and Networks 2014
NOKIA

Configurability of a new *RRC Connected Inactive* state in 5G

- Potential parametrization and configurability aspects of the new *RRC Connected Inactive* state:
  - **Mobility/location tracking management configuration:** RAN based mobility and location tracking, single/multiple cell-level tracking
  - **Measurement configuration:** Measurement configuration for cell reselection, camping, etc taking into account the existence of multiple air interface variants
  - **Camping configuration:** Single/multiple-RAT camping, capacity based camping, etc
  - **State transition/system access configuration:** State transition and RACH access optimizations



A service could be characterized based on its requirements, e.g., on mobility, security & privacy, reliability, bandwidth, latency, battery life, etc.

© Nokia Solutions and Networks 2014
NOKIA

Conclusion

- A new operational state model needed to support connectivity of critical applications, extreme power saving and mobility optimization in 5G.
- Efficient way to introduce a new state model is to design a low activity state supporting mobility.
- It is beneficial for the system access if the UEs are always connected to network and UE context is stored in RAN also during the low activity state.
- A new low activity state should be programmable to support various use cases and requirements, also unforeseeable.

© Nokia Solutions and Networks 2014


NOKIA