Targets, Design Rules and First Designs for the 5G Access Network

Bernd Haberland

10.12.2015 at ITG workshop: 5G System Architecture

Every success has its network

Alcatel·Lucent

Content

- What is driving 5G
- 5G Configurable Air Interface: From Service Abstraction to Profiles
- Requirements to 5G Edge networking
- 5G CRAN Architecture
- Flexible Processing Split
- 5G radio: Integrating multiple services on a common radio
- User Specific Control Channel
- Multi Connectivity
- Advanced Mobility Framework for 5G
- Take Aways

What's driving 5G?
Scenarios

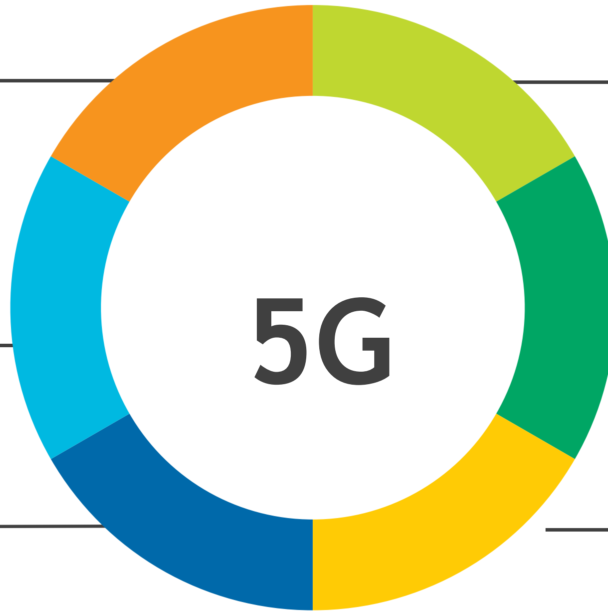
BROADBAND
Massive traffic capacity
Reduce Cost
Spectrum efficiency
Access new spectrum

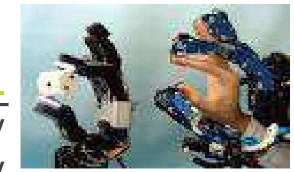
EXTREME DENSITY
Massive user density
User content

(Google)

INNOVATIVE SERVICES

Flexible bearer design
3rd party policy



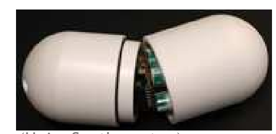


MISSION CRITICAL
Very low latency
High reliability
High availability
Security

(ZDF)

BATTERY LIFE
Signaling reduction
Energy optimization

NON TRADITIONAL DEVICES
Short packet
Sporadic access
More devices and more device types

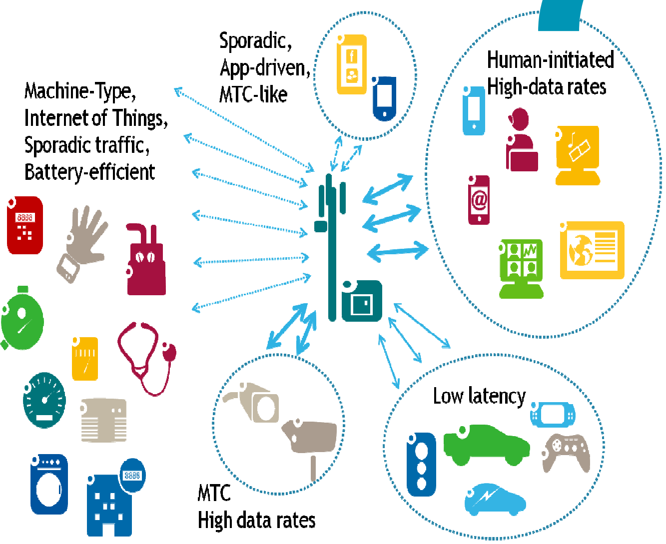


(Univ. Southampton)

5G should focus on solving these issues

5G Configurable Air Interface: From Service Abstraction to Profiles

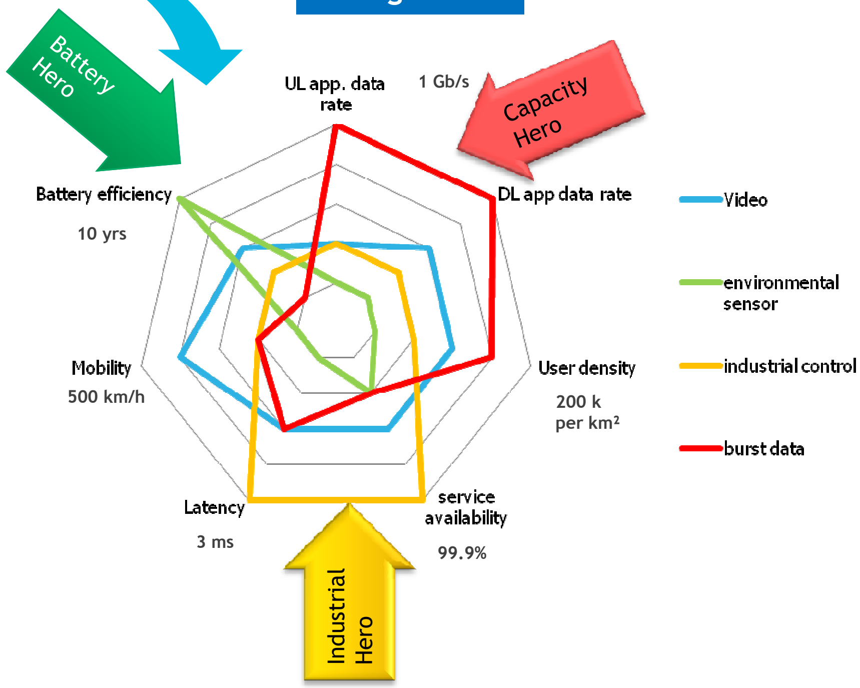
New and existing Services



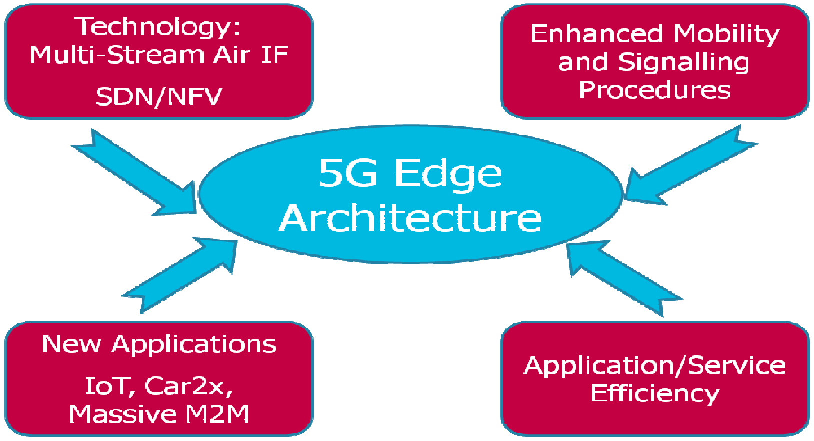
Abstraction

Richer Set of Service Options
Bitrate description GBR/N-GBR, peak, expected, sufficient
Latency (Packet delay): finer granulation, new **Low latency** option, average vs. first packet delay
Loss rate: finer granulation
Priority information (e.g. ARP): Availability class: best effort / prioritized
Activity: Background, streaming, very infrequent, etc.
Mobility category: fixed / nomadic /vehicular
Traffic type: Scheduled, Sporadic vs. Contention
UE power category: very low power (MTC), high power (WLL)
Security: Application privacy level, networking restrictions
Reliability: use case dependent
Networking: Routing restrictions, recommendations

Profiles & Configuration



Requirements to 5G Edge networking

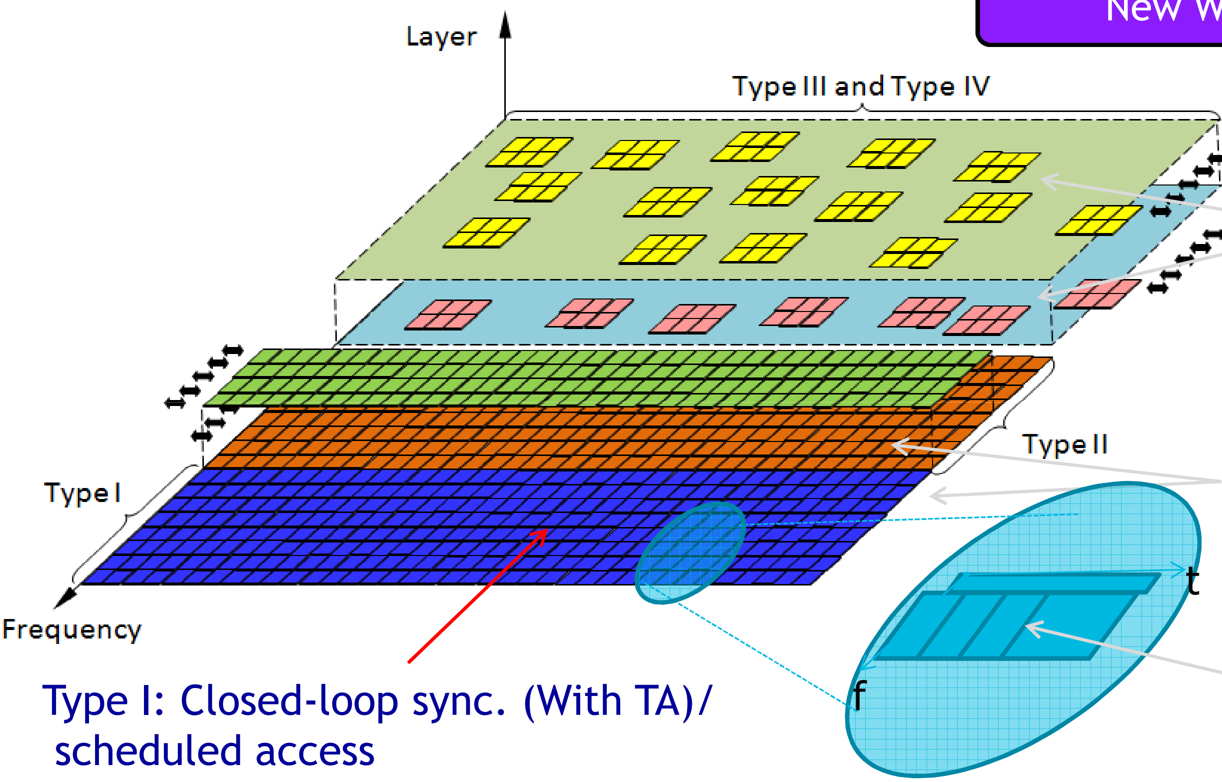


- Analyze the drawbacks/ bottlenecks of existing standards
  e.g. efficient transmission of small data packets
- Identify new technologies and their impact on a system
  (massive MIMO/ C-RAN/ MM-wave)
- Build a system which allows a future proof integration of upcoming technologies/services
- Build an architecture for a multi-service network which increases the flexibility without increasing the costs

CONCEPTS FOR DESIGNING A FUTURE PROOF 5G

5G radio: Integrating multiple services on a common radio interface

New Waveform (UFMC): Enabler for flexibility



Type III and IV: Open-loop sync., contention based access

- Ideal for sporadic short packets
- Type IV enables battery efficient low overhead (spread over time)

Type II: Open-loop sync. (no TA), scheduled access

- Enabler for high performance HetNet
- Scheduled retransmission

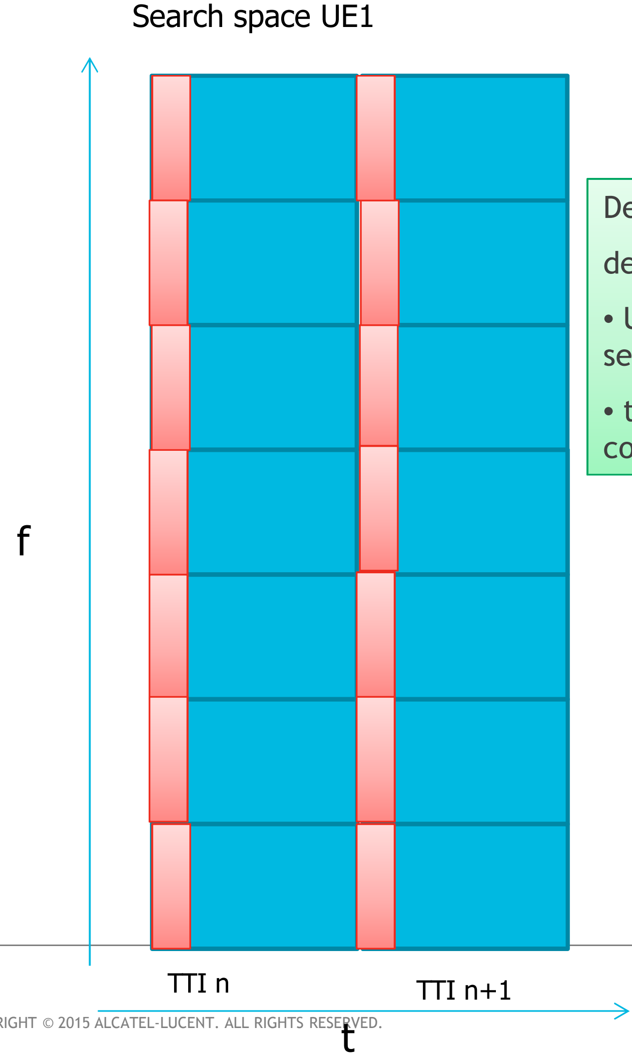
Type I: Closed-loop sync. (With TA)/ scheduled access

- for Mobile Broadband

Flexible Frame structure

- Enabler Low Latency Services

User specific Control Channel: Principle control channel structure

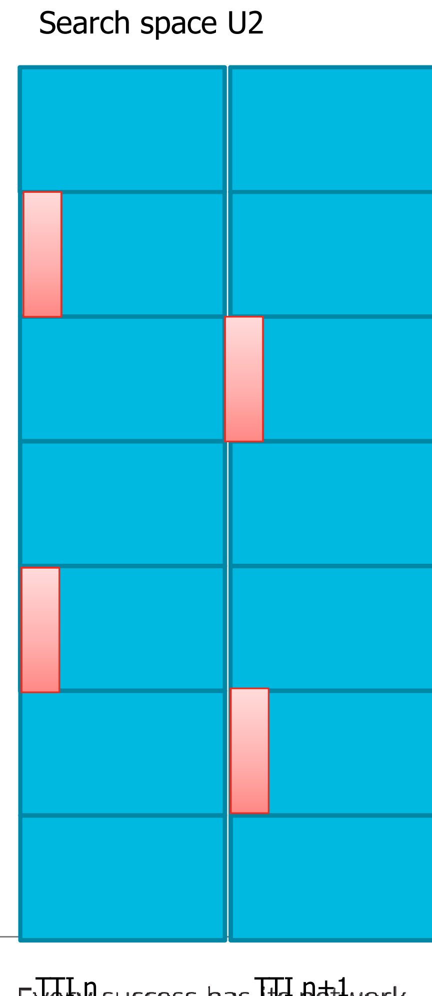


Density of search space

depends on:

- UE category and expected service
- transmission point (interference coordination)

Control channel
Search space
Information for UE ID

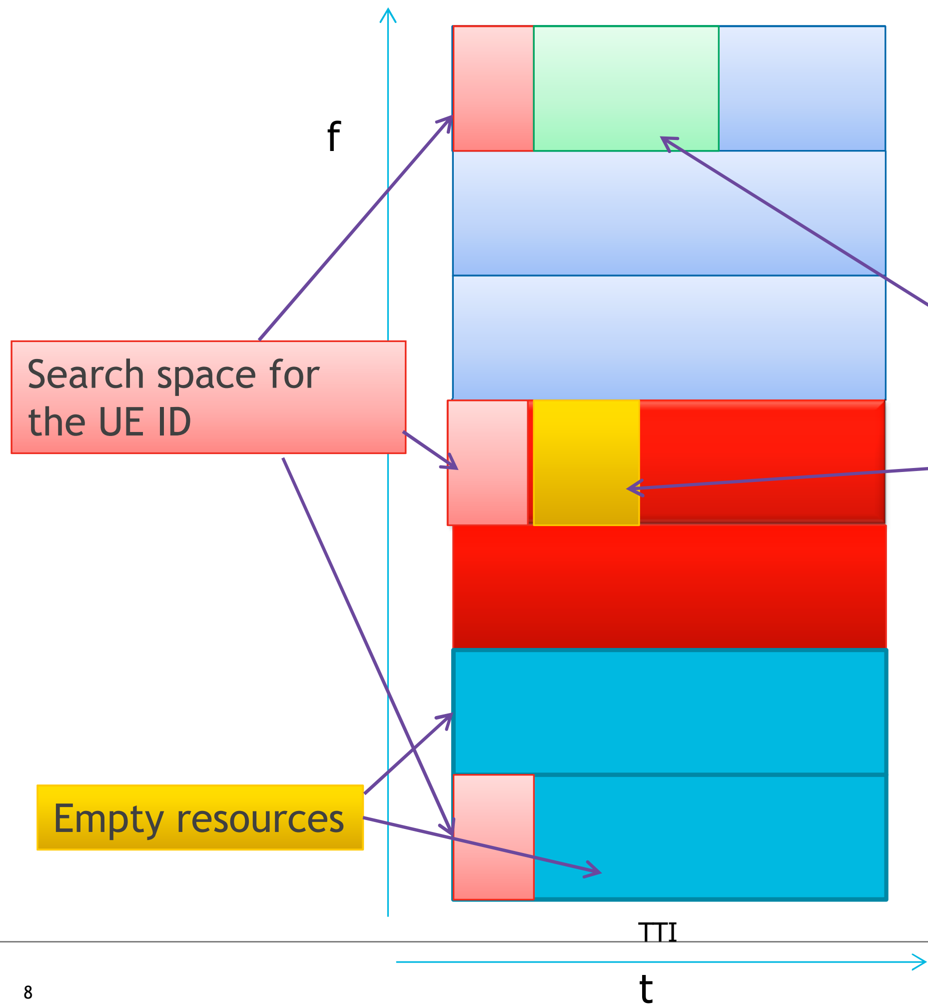


Control channels

can avoid collisions to support also ICIC for control signaling

Higher flexibility as E-PDCCH

Principle control channel structure



Content of the user specific control information is configurable and depending on device class and service requirement.

User specific

scheduling information (size adaptive to PRB allocation)

Control channel
DL search space
Information for UE ID

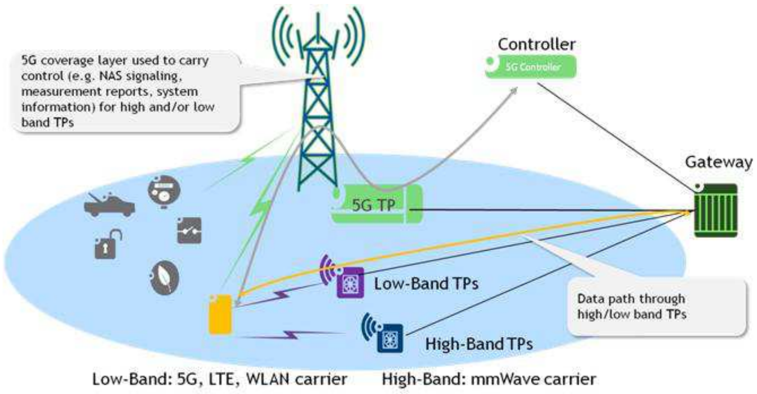
UE1 (User specific data
UE2 related part)
Data UE1
Data UE2

Spectral efficiency:

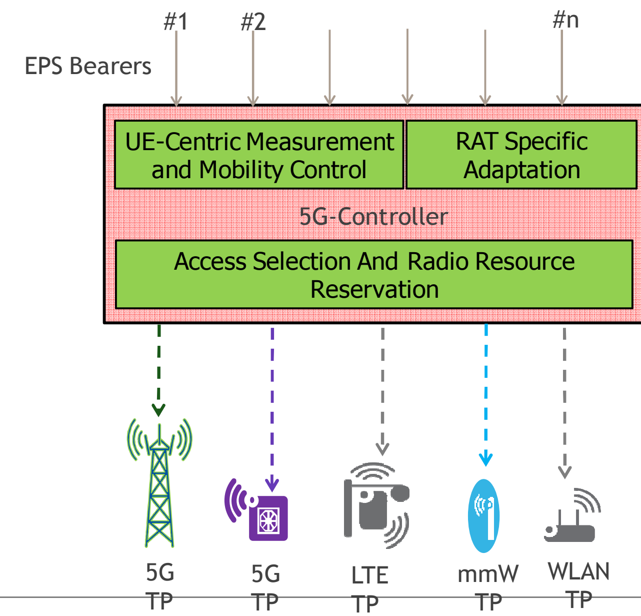
More search space capacity against adaptive DCI and no blocking of CCEs

Multi Connectivity

- Multi Connectivity (MC): Reliable service and user centric
  - Very tight integration of multiple RATs controlled by 5G network
    - Low Band: 5G, LTE, WLAN carrier
    - High Band: mm Wave carrier
- Our vision: Multi Connectivity (MC) one of the key enabler to meet 5G service requirements defined by NGMN



- Basis for Architecture
  - Integration of multiple RATs
  - Centralized connection control for optimized network management
  - Distr. radio resource management for autonomous operation of each node
- Key technical objectives
  - Capacity expansion: one control link (via Macro), multiple data links
  - Redundancy : multiple control and multiple data links



Advanced Mobility Framework for 5G

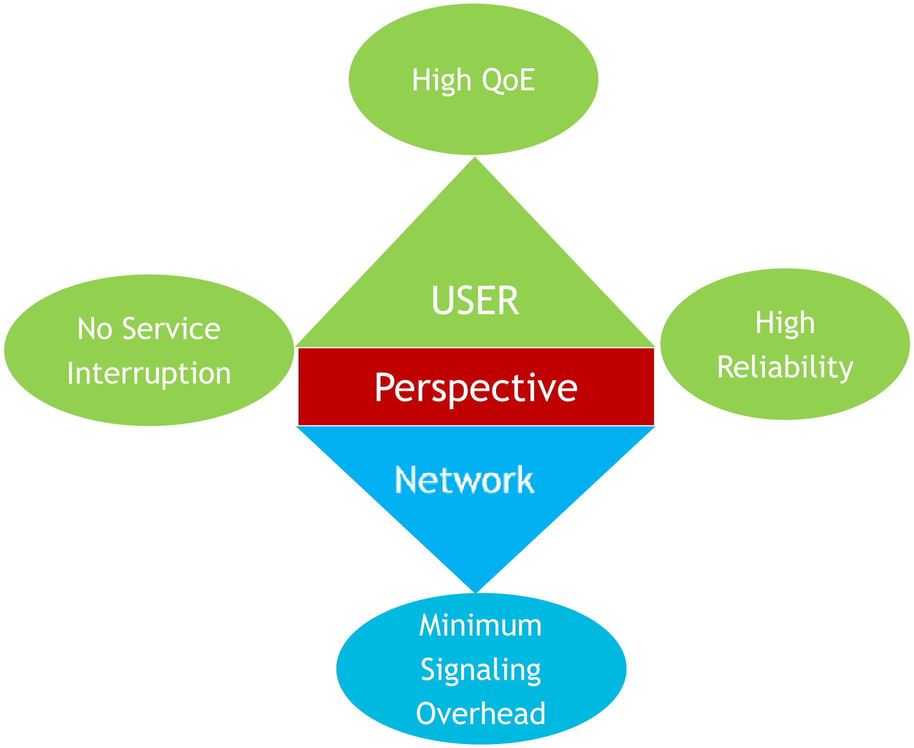
Introduction and Motivation

Objectives for 5G handover compared to 4G (LTE)

- High QoE
  - High Reliability, no interruption during transmission point change, no connection failures (call drops)
- Minimum Signaling Overhead
  - on air interface, within RAN and towards MME
  - faster execution

Our Vision:

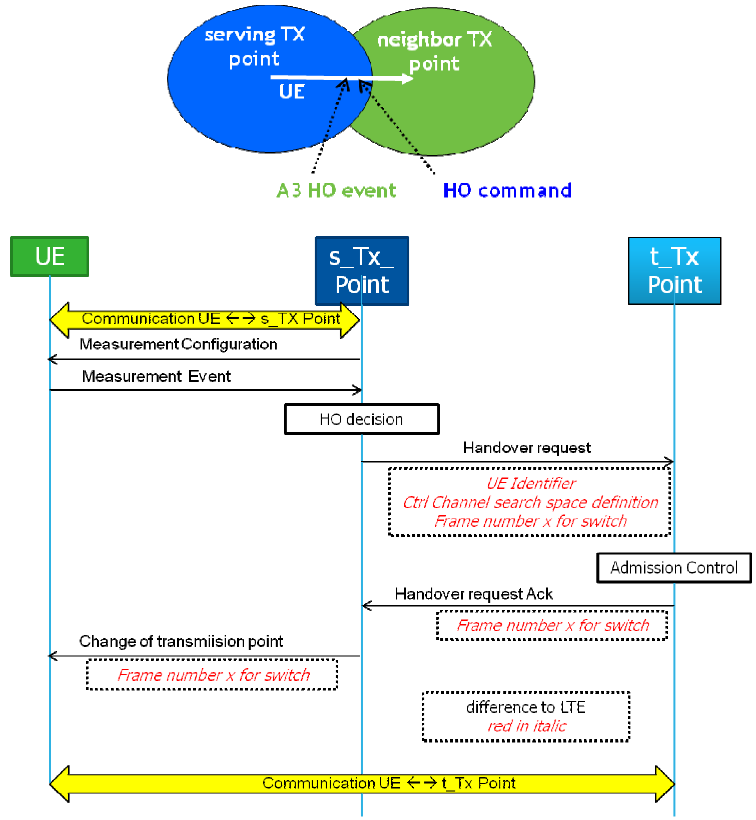
- Service aware 5G HO procedures,
  - **novel concepts for main service classes:**
    - **broadband services**
    - **small data packets services (SDP): sporadic , delay tolerant data application**
- Network controlled and UE centric HO procedures



MORE EFFICIENT SERVICE AWARE MOBILITY PROCEDURES

Advanced Mobility Framework for 5G
Broadband Services

- User Perspective: Faster and Seamless handover for broadband services
  - High QoE, High Reliability, No Service Interruption

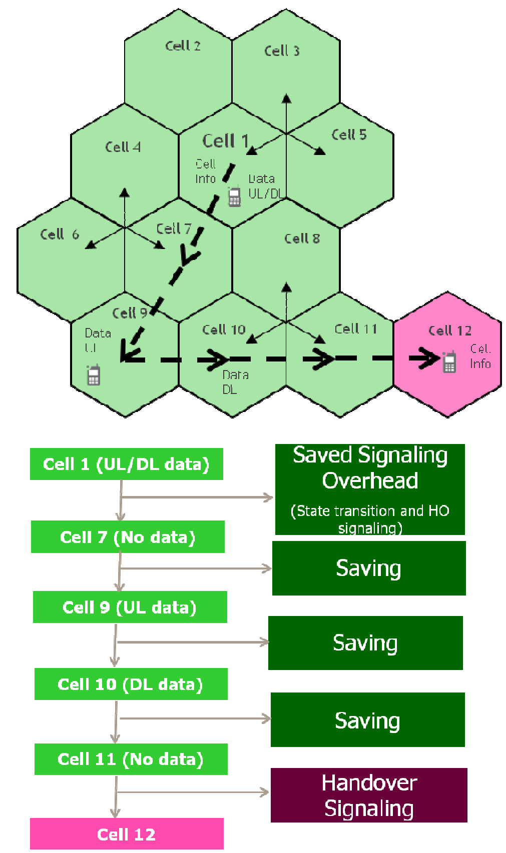


- User Centric Control Channel:
  - no random access procedure (RACH) for handover
  - faster switching of UE from source Tx point to target Tx point
  - no RRC reconfiguration
  - Common UE specific control channel search space

FAST AND RELIABLE HANDOVER FOR BROADBAND DATA

Advanced Mobility Framework for 5G
Small Data Packets Services (SDP)

- Moving tracking area (MTA) for non real-time, delay-tolerant and sporadic traffic
  - background traffic and messaging (e.g. WhatsApp application)
- Main ideas
  - Network-controlled UE-assisted assignment of MTA
  - Known UE context within MTA, i.e. a 5G UE-centric concept
  - Keep UE in “Low overhead RRC connected” state within MTA
    - save Idle-Active Signaling
  - UL SDP within MTA: Connectionless transmission
  - DL SDP within MTA: Intelligent data forwarding/routing within MTA
- Further Research
  - Extension of MTA concept with multi connectivity
    - definition of mobility clusters with further reduction of signaling messages towards core network



EFFICIENT MOBILITY WITH LIMITED SIGNALING OVERHEAD

Take away

➔ Wide range of services
from machine traffic to virtual reality

➔ The system adapts to the service –
air interface and network being configured for the service
This requires a service description

➔ Flexibility and Scalability with CRAN approach

➔ Broadband: Efficiency is key
Design for energy, spectrum and cost efficiency

➔ Low latency and high availability are provided <u>as options</u>
allowing for higher resource consumption and cost

➔ Spectrum: mm-wave links are seamlessly integrated and
spectrum sharing is supported