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Systems Architecture

On the Benefits of RAN Virtualisation in C-RAN Based Mobile Networks

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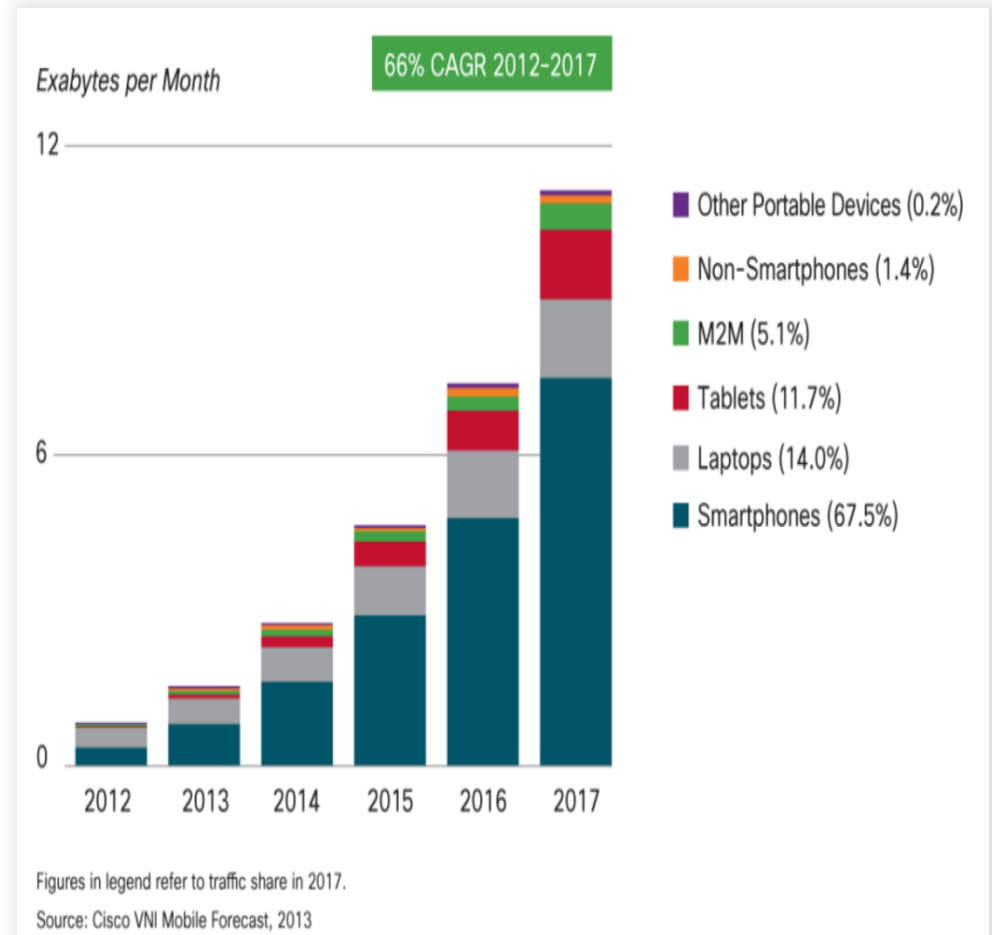
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Driving the Change – 5G

In 2020, 5G technologies want to meet the following expectations:

- 1000x traffic growth
- Much higher power efficiency
- Gigabits per second user experienced data rate everywhere
- Low latency wireless communications (1ms) for new applications (tactile internet)
- Native support for device to device communication
- Native and effective support for low cost machine to machine communication



5G Technology Megatrends

New network architecture

- Multi-RATs
- No cell edge & densification
- Centralized & virtualized RAN
- Wireless backhaul
- Wireless optical interface
- Software defined network

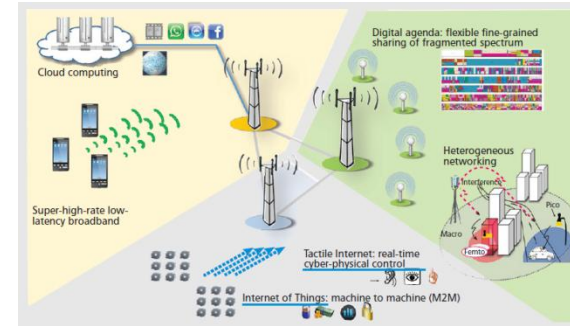
FUTURE RADIO ACCESS
NETWORKED SOCIETY VISION



Ericsson's vision for 5G networks

New air interface

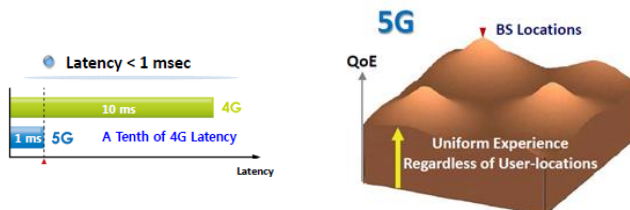
- New waveforms & broadband
- Massive MIMO & beamforming
- mmWave
- Full duplexing



New air interface needed to cope with different requirements

New metrics for network and users

- Power efficiency
- Low latency
- Huge number of devices
- User QoE & fairness



Samsung's vision on new 5G metrics

New service models and applications

- M2M, V2V & D2D
- Visible Light communication
- Remote machine control
- Augmented reality for mobile



Augmented reality for mobile



Interactive gaming



Heterogeneous Networks

Pros

- Short term fix
- Provides denser coverage
- Less users/devices per base station

Cons

- Multiple user identities
- Multiple access techniques
- Multiple authentication and authorisation techniques
- Independent resource management techniques per radio technology
- Inefficient access control and data routing
- Increased intercell interference
- More handovers



Effects on the Core Network

- LTE, 42% increase in signalling over 3G/HSPA
- Approximately, 120 transactions per subscriber per busy hour
- Over 50% of the signalling is related to mobility and paging



Multi-RAT Virtual-RAN

5G-Goal is to optimise use of Multi-RAT and seamlessly combine them into a single virtual-RAN

Pros

- Unified access control and authentication
- Common mobility management
- Common radio resource management
- Optimized routing paths to devices
- Spatial multiplexing decreases interference
- Better frequency reuse across the network

Cons

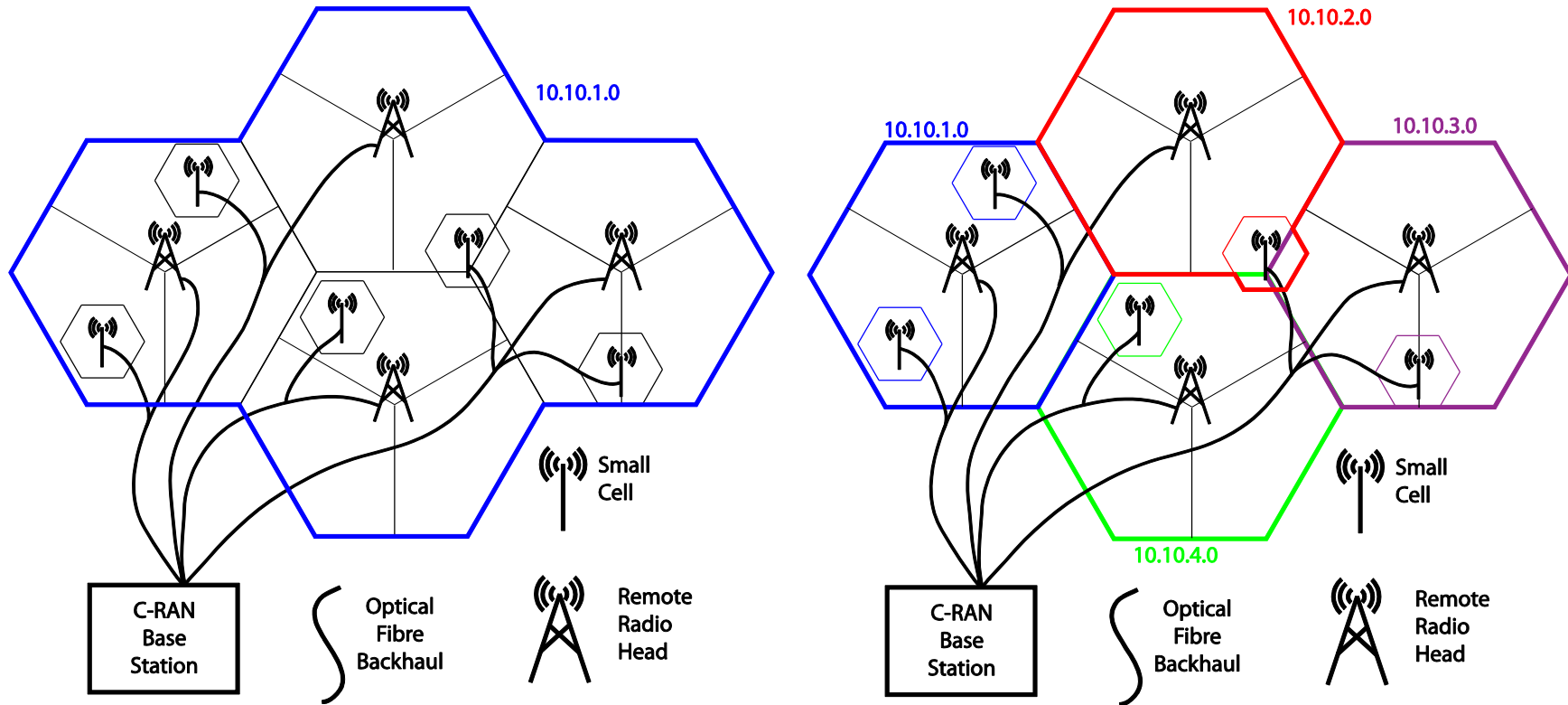
- Complex inter cell coordination



How Can RAN Virtualisation Help?

- Move intelligence to network edge
 - Faster mobility management
 - More efficient inter cell coordination
- Isolate EPC
 - Reduced signalling load
 - Minimise changes needed to introduce new technologies
- RAN slicing for sharing infrastructure with multiple operators
- More efficient use of resources and energy

Resource Abstraction for EPC

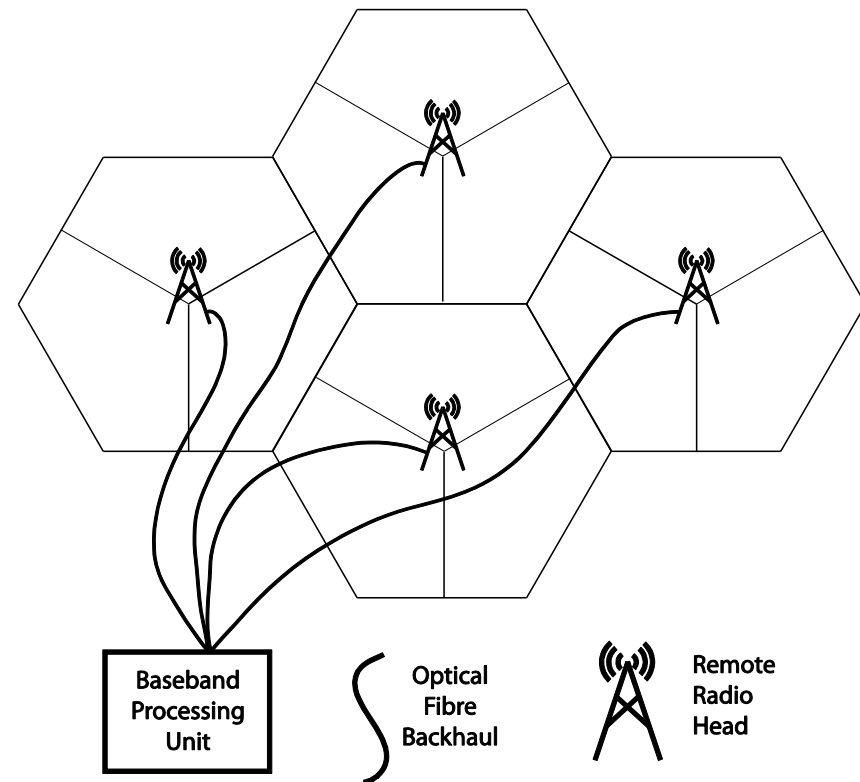


1) Complete Abstraction

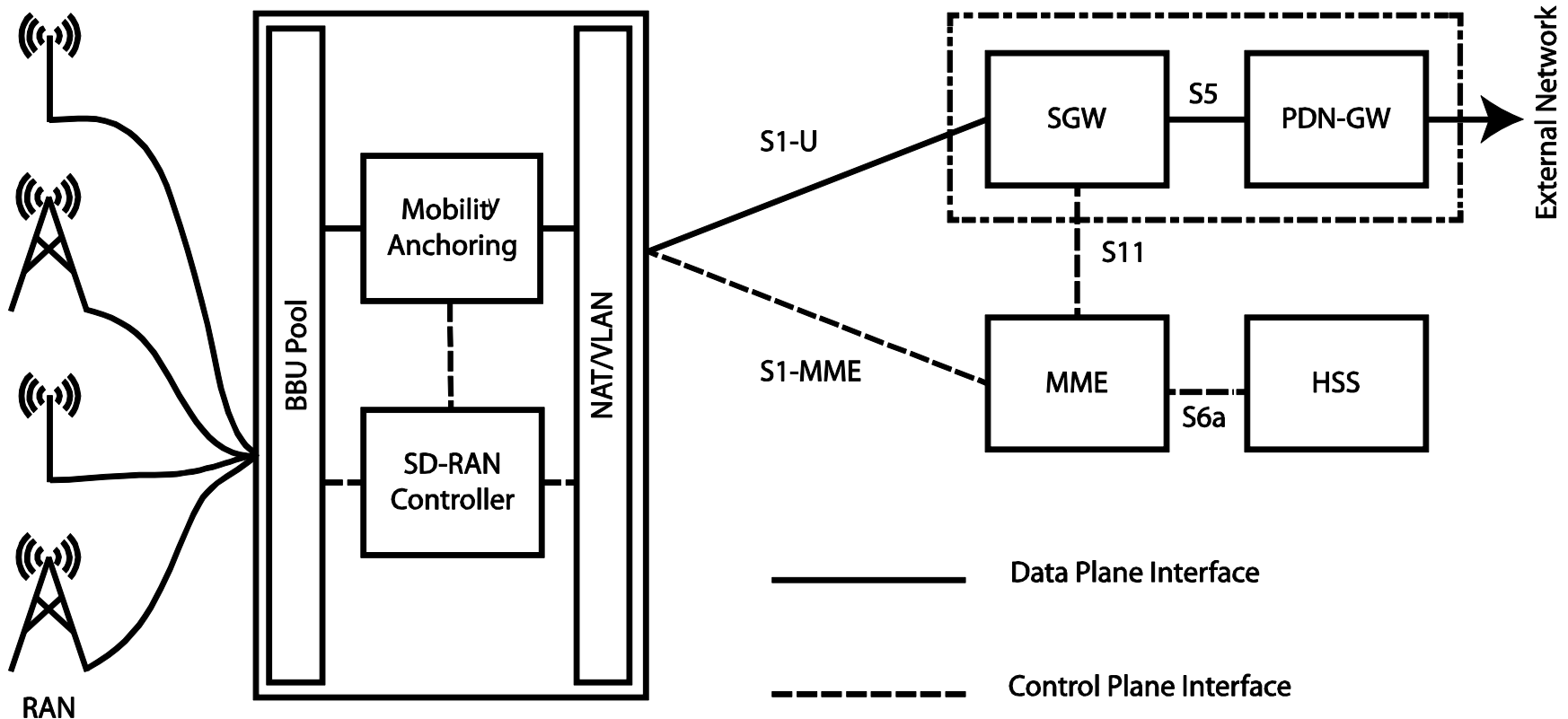
2) Abstraction within Macro cell coverage area

Building upon C-RAN

- Multiple radio heads connected to centralised baseband pools
- Centralised processing required for SD-RAN controller already present



Proposed Architecture





Software Defined RAN

- Build upon the system proposed by CreateNet
 - Controller maintains pools of resource blocks for all base stations
 - Resource blocks assigned to specific UE over virtualised RAN
 - Matrix of interference measurements between BS and UEs used to choose best connection
- Extensions required to support concurrent scheduling of resources from multiple BSs



Future – Device Centric Architecture

- Functional division
 - Macro cells provide control and data
 - Small cells data only
- Better user experience and efficiency
 - Best cell chosen separately for UL and DL
 - Small cells disabled when not in use
- Resource abstraction and SD-RAN allow implementation with no EPC issues



Related Works

- SoftRAN and V-Cell
 - Use SD-RAN to group BS into C-RAN like big BS
 - Improve mobility/load balancing with edge intelligence
- Both focussed on current generation
- We plan to utilise and build on the SD-RAN controller used in V-Cell



Development Road Map

- Collaborative project with CreateNet
 - Validation of SD-RAN design on OpenAirInterface
 - Develop API extension for multi-cell technologies
- Build C-RAN testbed based on OpenAirInterface
- Initial virtualisation framework testing
 - Mobility with SD-RAN API
 - Multi-Cell scheduling with API
 - V-RAN abstraction of physical resources to EPC
- Future – separate control and data plane scheduling on different cells



Summary

- We propose a virtualisation framework building upon C-RAN
 - Abstract resource representation to EPC minimising signalling
 - SD-RAN providing edge intelligence for mobility and inter cell cooperation



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Thank you for listening...

