Adaptive and Software Defined 5G Air Interface for 5G Wireless Network

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To enable any application and any service to connect everything and anything

5G Air Interface Framework



Service/Application Oriented Radio Access



Network serves UEs through dynamical configurable virtual data pipes to meet QoS requirements of different services. Page 1

Single & Unified Air-Interface



Single Air Interface for All Applications



Unified air interface to support different waveform/multiple access scheme/TTI Co-existence of waveforms with different time-frequency granularities

Software Defined Air Interface



One size fits all -> AI Adaptation

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New waveform Candidates





What is SCMA? - Sparse Codebook Multiple Access



A new frequency domain nonorthogonal waveform
Sparsity of the codeword to enable overloading with reasonable Rx complexity

FEC Encoder





• SCMA codebook based on Multi-dimensional Lattice Constellation to exploit shaping gain and coding gain

Each UE stores a unique codebook

What is SCMA? - Scalable SCMA with Adaptive System Parameters



Number of codewords of an SCMA codebook: M Spreading factor: K Max number of layers (or codebooks/signatures) : J

Number of nonzero elements of each codeword: N

Compromise among spectral efficiency, coverage, detection complexity, connectivity, and link budget to adapt to different application scenarios

Why SCMA?

Enable Massive Connectivity

Overloaded signal superposition

Low multi-user detection complexity

Low signaling overhead and low latency with grantfree transmission Better Spectrum Efficiency

Shaping gain and coding gain from Multidimensional lattice constellation based codebook design

More reliable link adaptation with Interference averaging Better Scalability and Flexibility

Easy adaptation to different application requirements

Extra domain for multi-user resource sharing

Gain of SCMA



Gain of SCMA: - OL Multi-user Multiplexing

 OL Multi-user multiplexing without need of short term CSI information
 More flexible and robust link-adaptation mechanism

Gain of SCMA: - UL Contention Based Multiple Access

Grant-free UL multiple access based on SCMA blind detection:

- ~3X connected devices
- No dynamic scheduling singling overhead
- Low latency

Remove cell grid: UE ID replaces cell ID

Radio link topology change: point to point to group to group

Radio Access Virtualization - key Technologies

Hyper Cell and UE Dedicated Connection ID

Hyper cell: a virtual entity covering a group of physical TPs
A Logic entity ID is assigned to each hyper cell
UE dedicated connection ID
Decouple UE access with TP

Network maintains a TP and UE association map.
 UL centric measurement:

 For UL/DL TP clustering/optimization, mobility management, link adaptation....
 UE measurement assisted

Low Cost Deployment

Dynamically configure virtual transmit nodes
UE centric transmit node optimization and reception node optimization dramatically reduce the complexity.

Robust Link Adaptation and Uniform Data Distribution

•UE cooperation allows long term CQI based link adaptation
•No need for fast link adaptation
•Cell edge data rate enhancement

Autonomous Ad-hoc UE Cooperation Strategically deployed ((•)) terminal $((\mathbf{q}))$ $((\mathbf{\phi}))$ ((•)) (()) (() ((•)) UE1 **d4 d1** do 22 **UE0 d1 d2 d4 d5** ACK UE2 d5 **d2**

Ad-hoc UE group based cooperation

- Autonomously generated
- Not rely on dedicated helping UE(s)
- **Enhance network** reliability

Boost Performance By Adding Strategically Placed Help UEs

UE Centric Virtualized Physical Channels

- Re-define physical channels to support radio access virtualization
 - Cell centric -> UE centric
- Virtualization of data channel and signalling channel offers more scheduling flexibilities.
 - Boost data and control capacity
 - Better energy saving
 - Better mobility management

Virtual Data Pipes Broadcast common control/virtual dedicated control UE Centric channel sounding & Measurement

SFN Synch

Virtualized PHY Channel Designs

Intelligent Spectrum Utilization

Key Technologies:

 Single AI covers all spectrum bands

 Efficient utilization of the spectrum by different nodes and link

Improve the spectral efficiency

» Reduce the interference.

> Joint optimization

Integrated Air Interface Central Spectrum Management Controller

Self-Optimized WN

Air Interface Design Principle Change

UE centric

Virtual UE connects to logic access point

Service-Oriented

Interference free

Cloud group computation based

Network oriented measurement

Thank you www.huawei.com