

# ***3G evolution***

## ***Current status and future steps***

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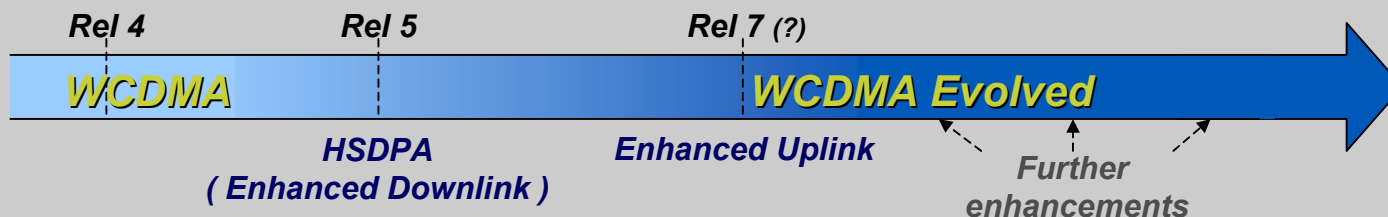
## 3G evolution

### Why an evolution of 3G cellular standards?

- To adapt to new or modified user / operator requirements
- To ensure competitiveness

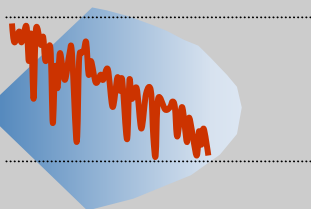
*The evolution has already begun and will continue ...*

### WCDMA → WCDMA Evolved

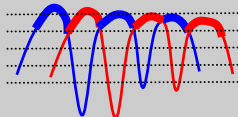
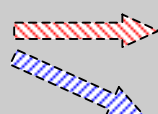


*Similar evolution for cdma2000/1x in 3GPP2*

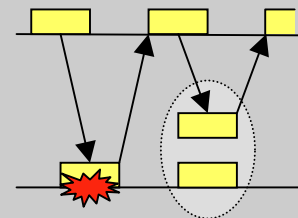
## Key characteristics of HSDPA ( 1<sup>st</sup> step of WCDMA Evolved )



Fast Link Adaptation



Channel-dependent Scheduling



Fast Retransmissions with Soft Combining



2 ms

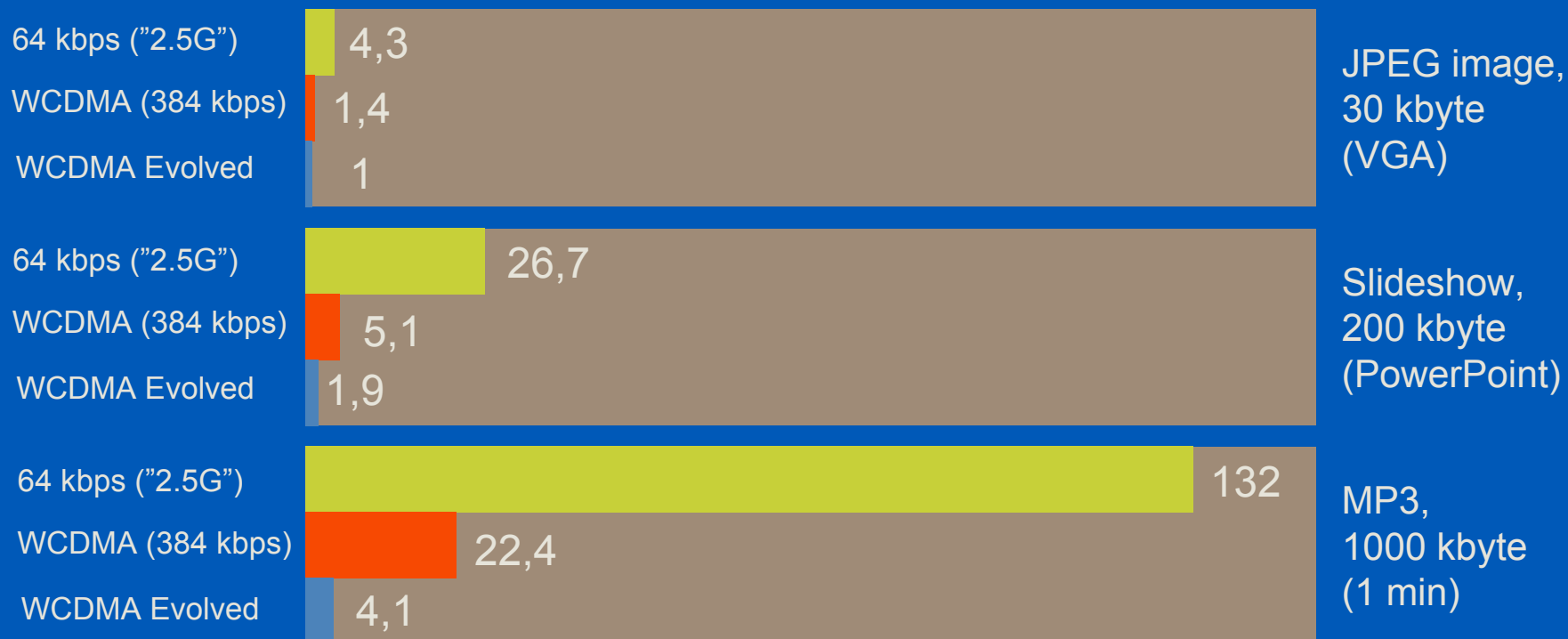
Short TTI

### Significant benefits for packet data

- Peak data rates: up to 14 Mbps !
- Roughly 3 times higher capacity !
- Significantly reduced delay !

# File download performance

Delay (s)

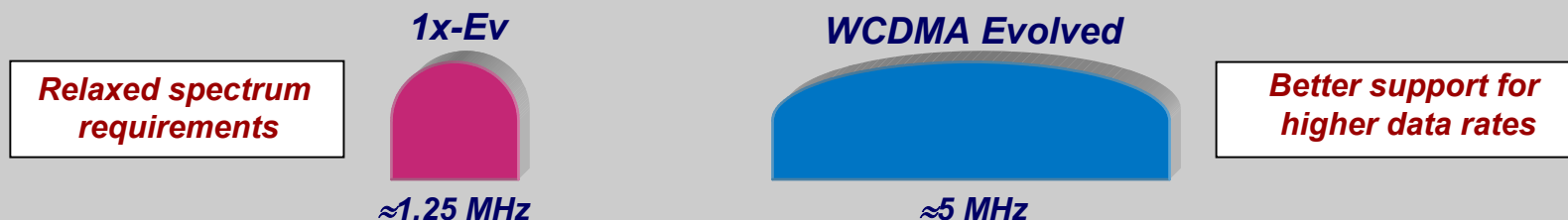


## WCDMA Evolved (HSDPA) vs. cdma2000/1x evolution (1x-Ev)

### Similar basic technologies

- Originate in DS-CDMA techniques
- Shared-channel ( “fat pipe” ) transmission for high-speed downlink packet data
- Similar frame length, etc.
- Use of fast link adaptation, channel-dependent scheduling, Hybrid-ARQ with soft combining, ...

### Bandwidth is the main difference



## ***Further steps into WCDMA Evolved***

### **Enhanced uplink in 3GPP**

- Improved uplink capacity*
- Reduced delay*
- Improved coverage for high data rates*

***Further improved performance and service provision for packet data***

*Similar work already under way in 3GPP2*

### **Possible further evolution steps**

- MIMO processing (?)*
- Further improved broadcast support (?)*
- Wider bandwidth (?)*
- ... ( many other possibilities )*

***3G standards will continue to evolve !***

## **3G enhancements**

**Enhancements to 3G standards ( = 3G Evolution )**

**Enhancements within the framework of current standards**

- *Advanced receiver algorithms*
- *Advanced antenna solutions*
- *Improved radio-network algorithms*
- ...

***3G will continue to improve also within current standards !***

## ***Example: Advanced receiver algorithms***

***HSDPA performance may be limited by intra-cell interference  
( channels subject to substantial frequency selectivity )***

**Impact can be significantly reduced by applying  
more advanced signal processing at the terminal**

***Many alternatives: G-RAKE, Chip-level Equalization,  
(Multi-path) Interference Cancellation, etc.***

***Part of future baseline implementations***

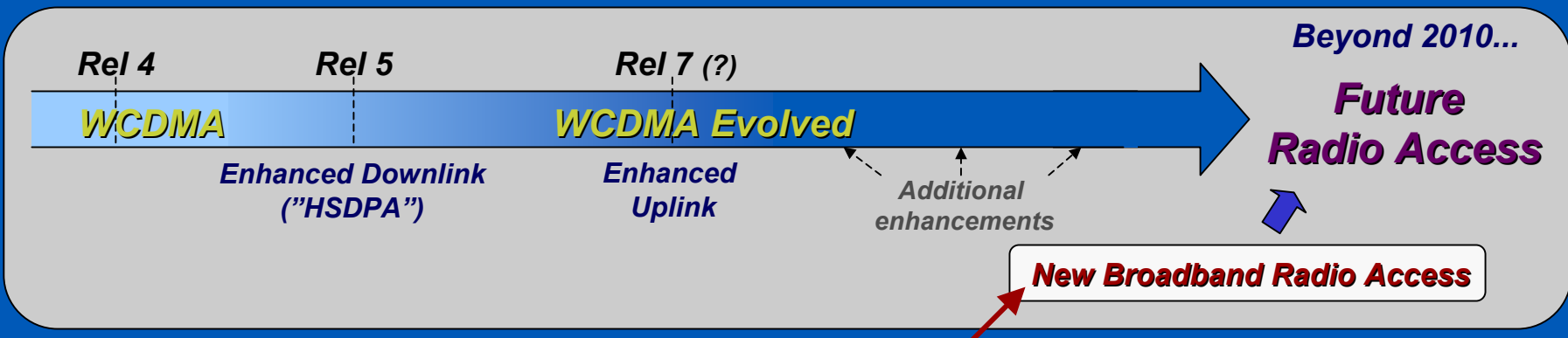


***Improved system performance ( capacity and coverage )***

***Will also lead to improved service provision***

## And then ...?

**Possible need for new broadband radio access ( "4G" )**



*Dramatic step in terms of capabilities*

**Basic research !**

*WWI ( Europe ), mITF ( Japan ), the "Future" project ( China ), ...*

## **Conclusions**

**3G is evolving and will continue to evolve ( WCDMA → WCDMA Evolved )**

- HSDPA is the first step towards WCDMA Evolved**
- Enhanced uplink, MIMO (?), ...**
- Similar evolution of cdma2000**

**Significant enhancements in performance and service provision !**

**Two very good standards that will be even better !**

**Thank you !**