

# LTE-A (Rel10/11) against the Green Radio Framework

for UKCSB 13<sup>th</sup> December 2011

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NEC Telecom Modus

v0.1

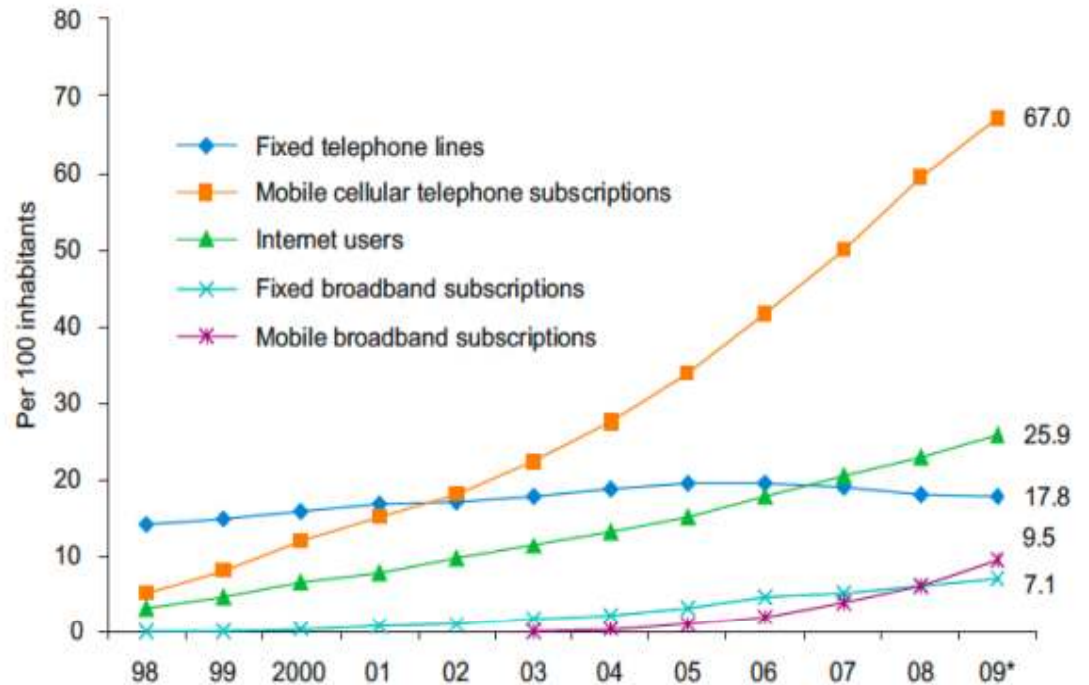
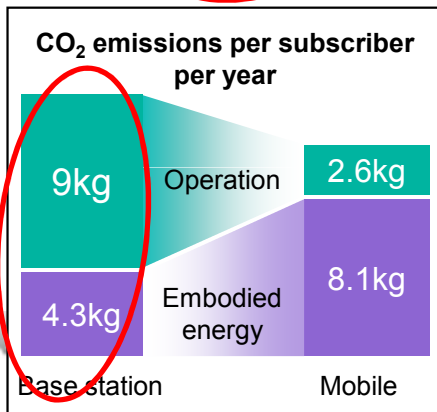
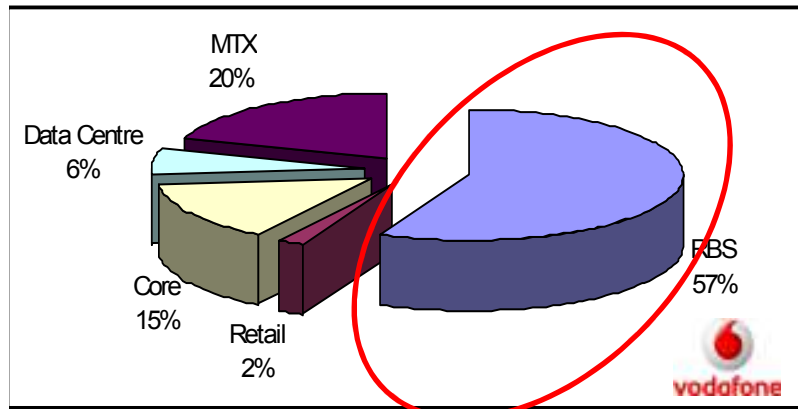
# Presentation Overview

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- Eco-system for setting the industrial agenda
- Green architectures
- Access platform models
- System level thinking
- NGMN call to action
- Start thinking about the approach again
- New techniques
- Conclusions



# Green Radio

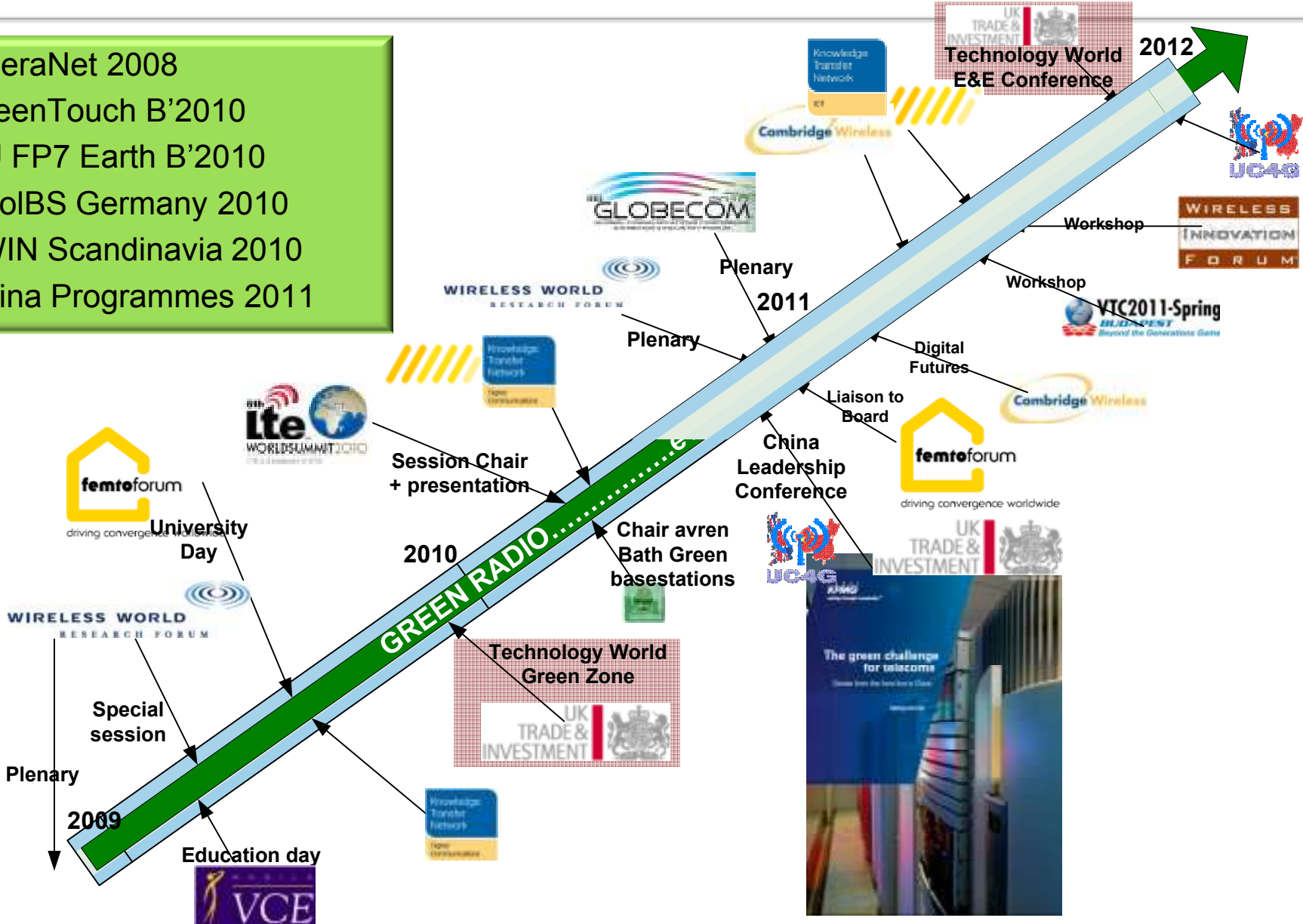


21 April 2008

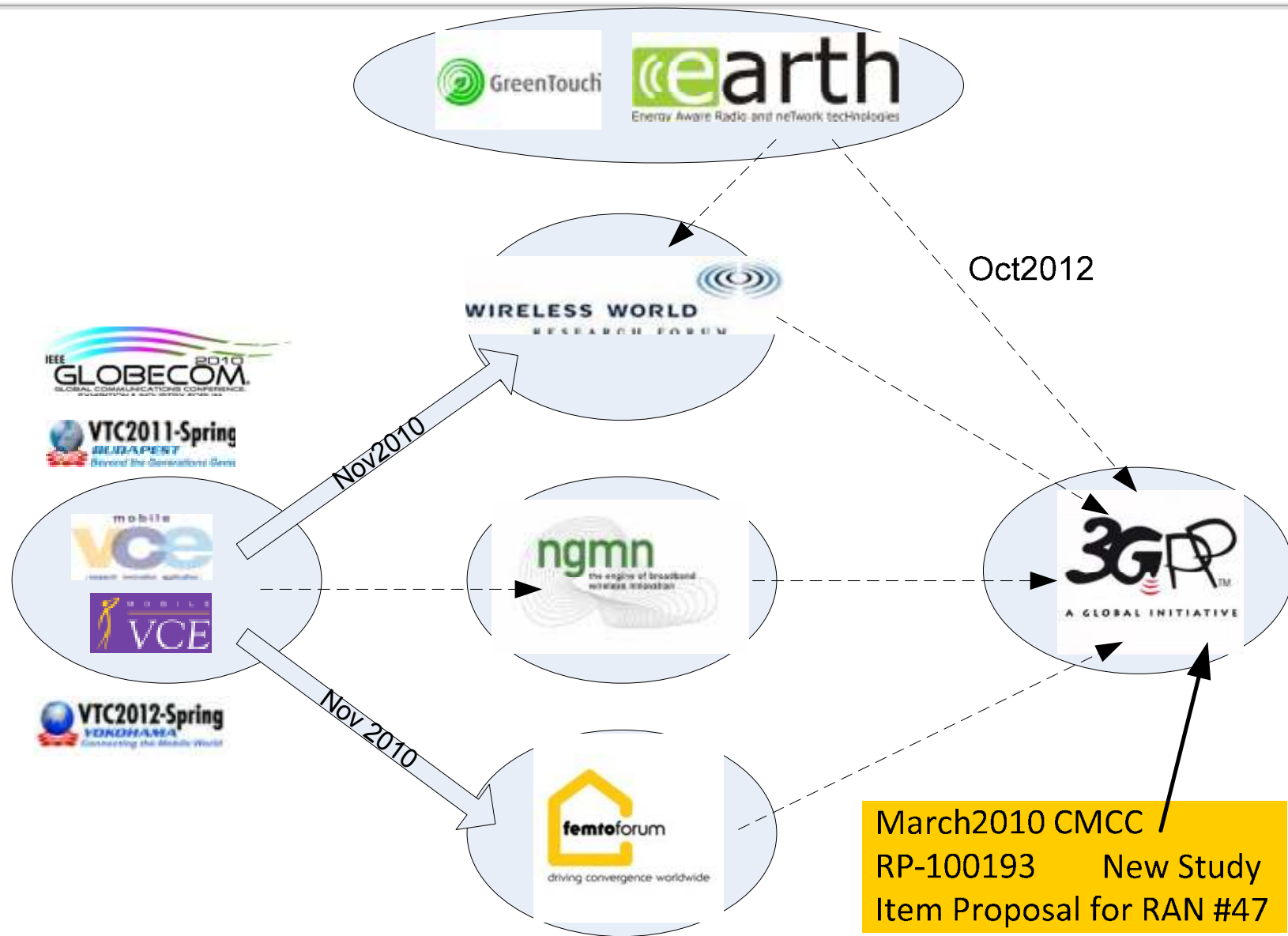
Vodafone Group today announces that by 2020 it will reduce its CO2 emissions by 50% against its 2006/7 baseline of 1.23 million tonnes. This target will be achieved principally by improvements in energy efficiency and increased use of renewable energy.

# UK working core with Global perspective

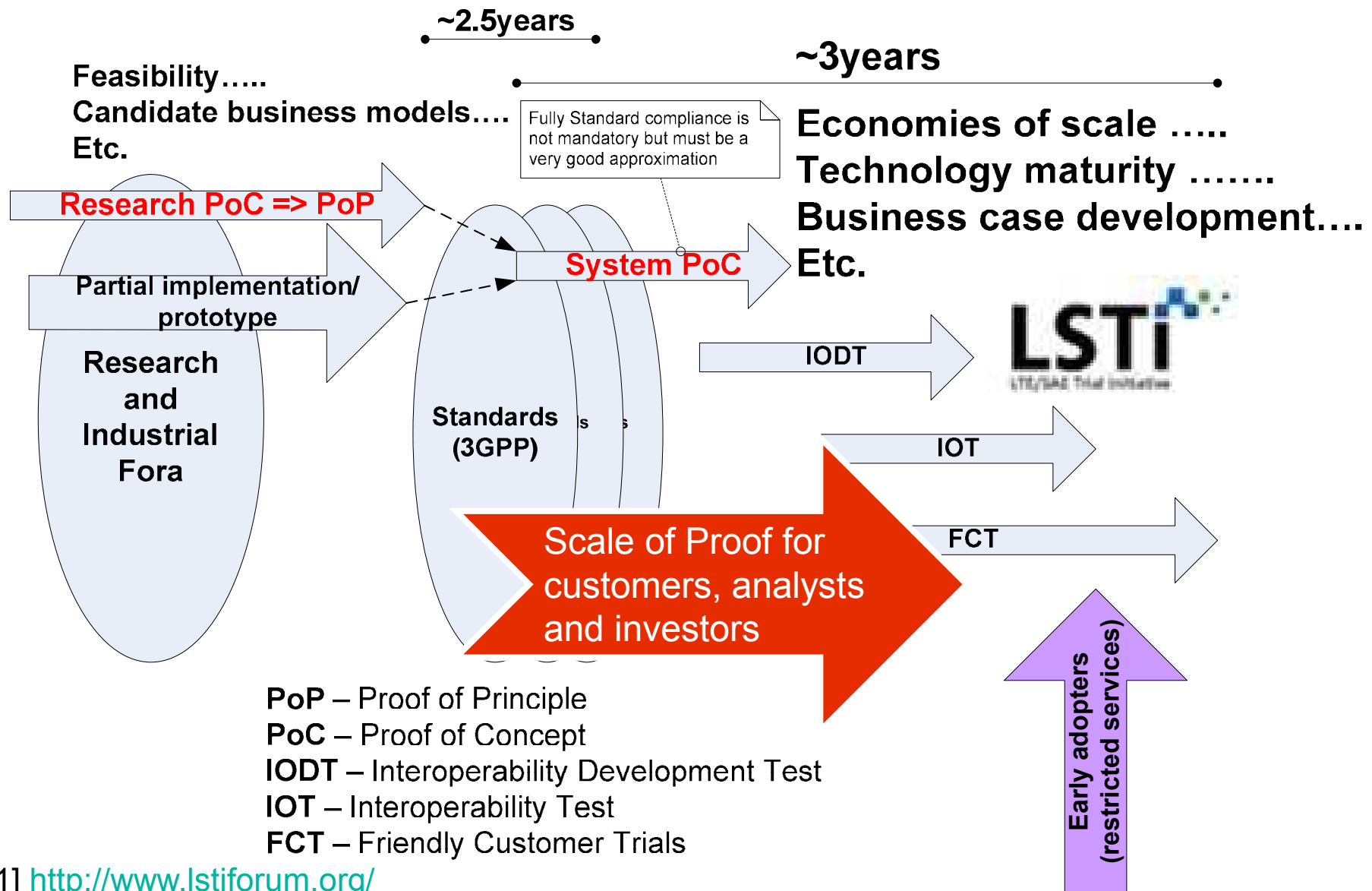
- OperaNet 2008
- GreenTouch B'2010
- EU FP7 Earth B'2010
- CoolBS Germany 2010
- eWIN Scandinavia 2010
- China Programmes 2011



# Eco-System for setting the agenda



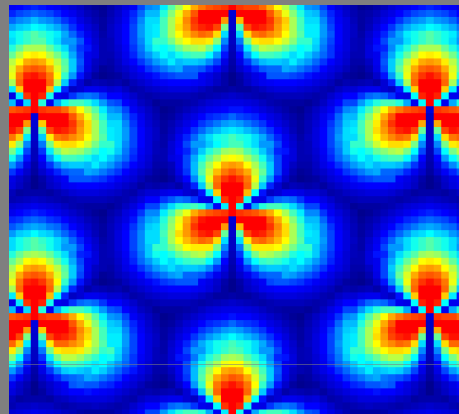
# Last steps to consensus



[1] <http://www.lstiforum.org/>

# Key Green Architectures

**LTE Baseline: Medium Density of Micro-cells**

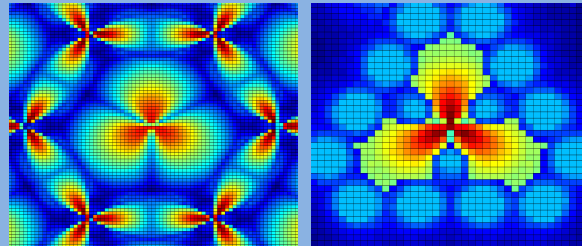


3 Sector Freq. Reuse 1  
SISO  
RR Scheduler

High Load: 800W/km<sup>2</sup>

Average ERG: 60%

**Low Density of Macro-cells with Cell-Edge Techniques**

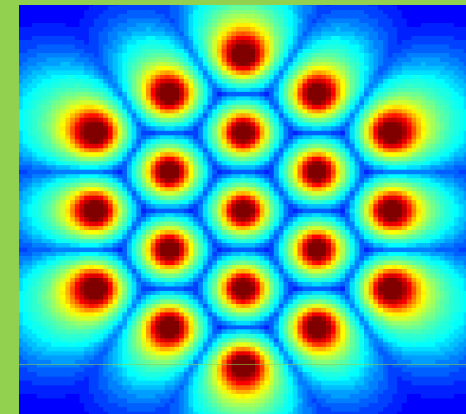


3 Sector Freq. Reuse 1  
2x2 SFBC MIMO  
Coordinated Scheduler  
Mechanical Relaying  
Wi-Fi Offloading  
Co-Freq. Wireless DF Relays

High Load: 420W/km<sup>2</sup>

Average ERG: 79%

**High Density of Low Power Pico-cells**



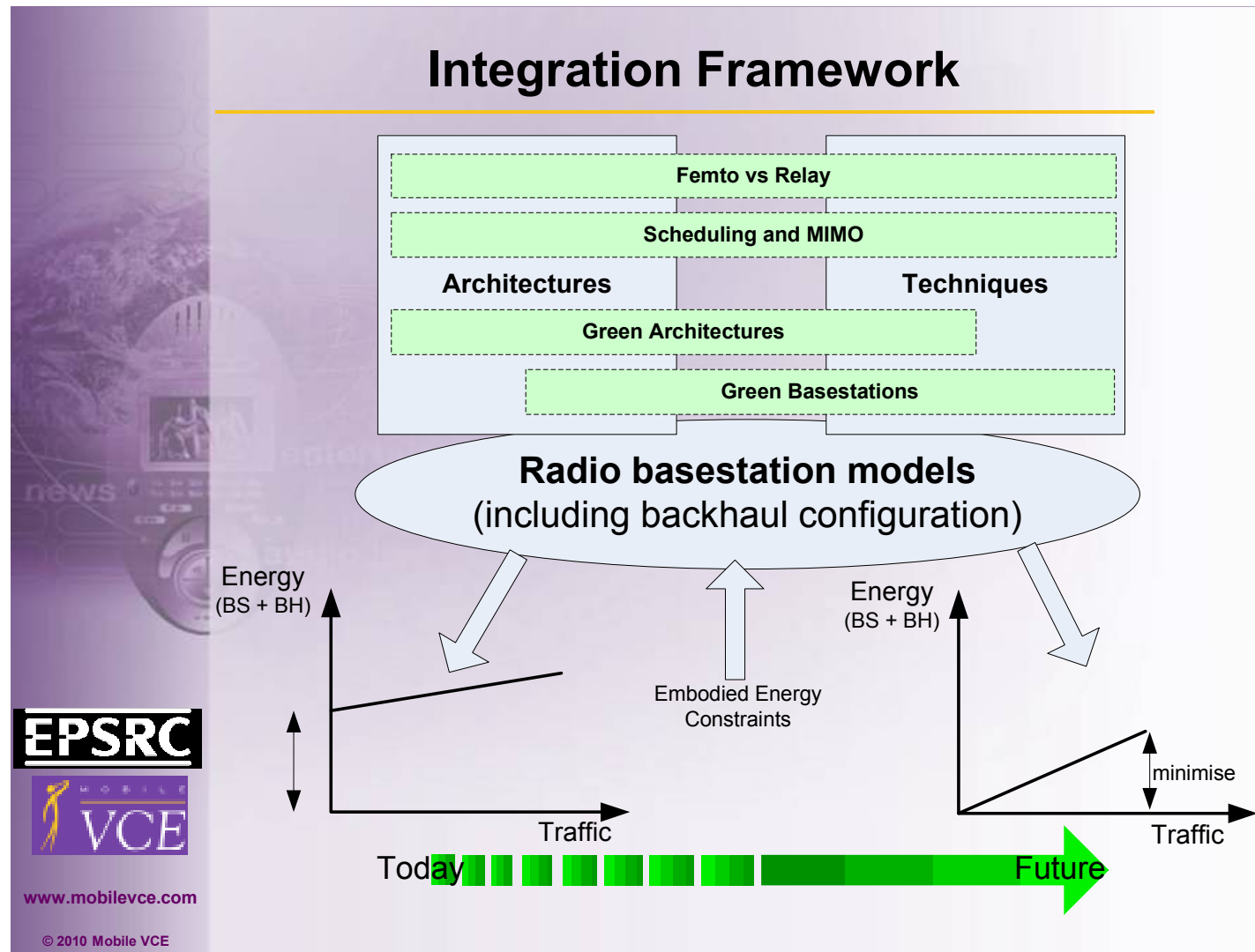
1 Sector Freq. Reuse 1  
2x2 SFBC MIMO  
Coordinated Scheduler  
Mechanical Relaying  
Wi-Fi Offloading

High Load: 300W/km<sup>2</sup>

Average ERG: 85%

*Operational ERG for HSPA Reference of 3 Sector, Reuse 1, 2x2 SFBC, Micro-Cells*

# Modelling for ICT Systems power/energy profile is necessary to target innovation in Standards

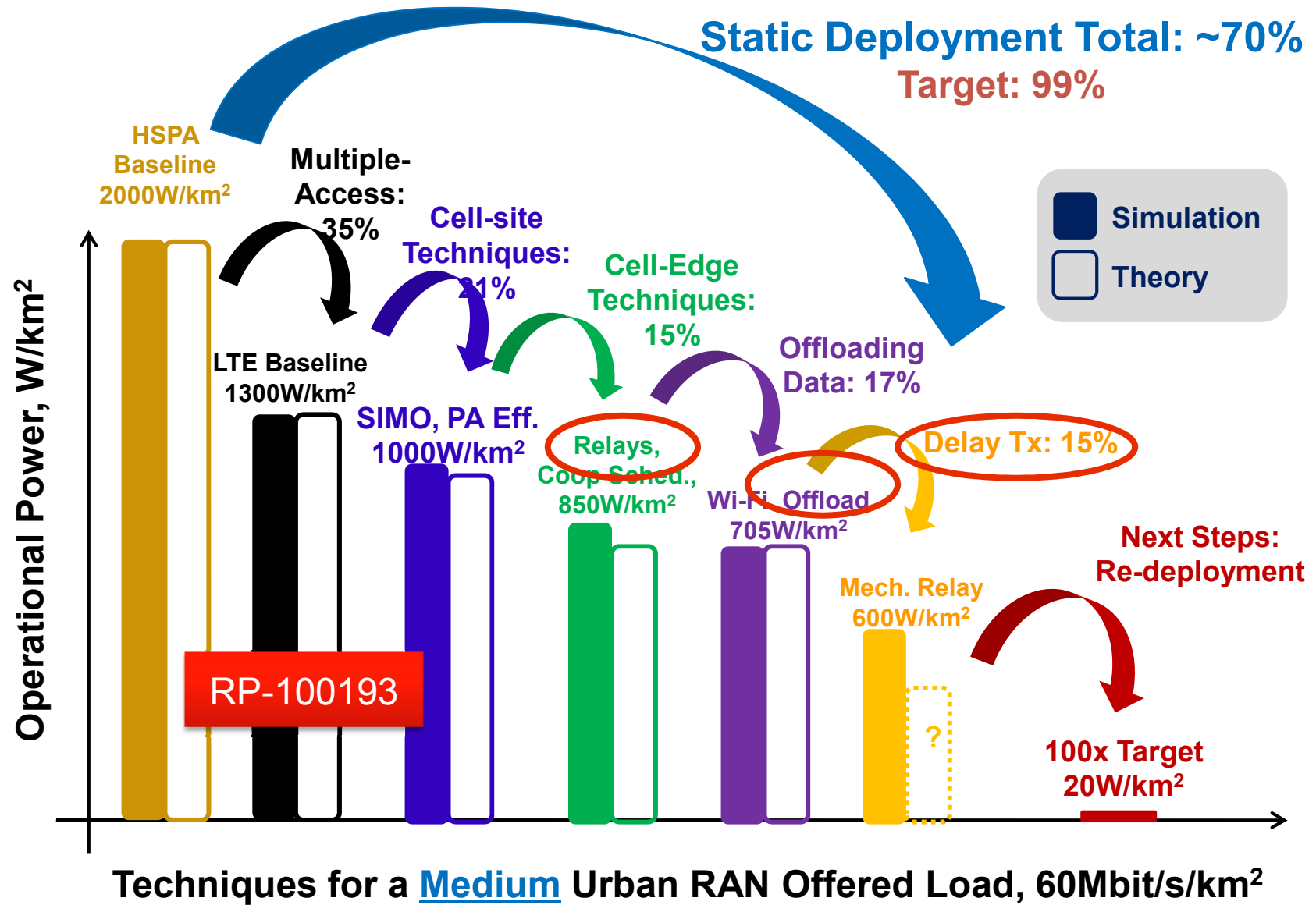


Presented by MVCE GR at Wireless World Research Forum plenary Nov'2010

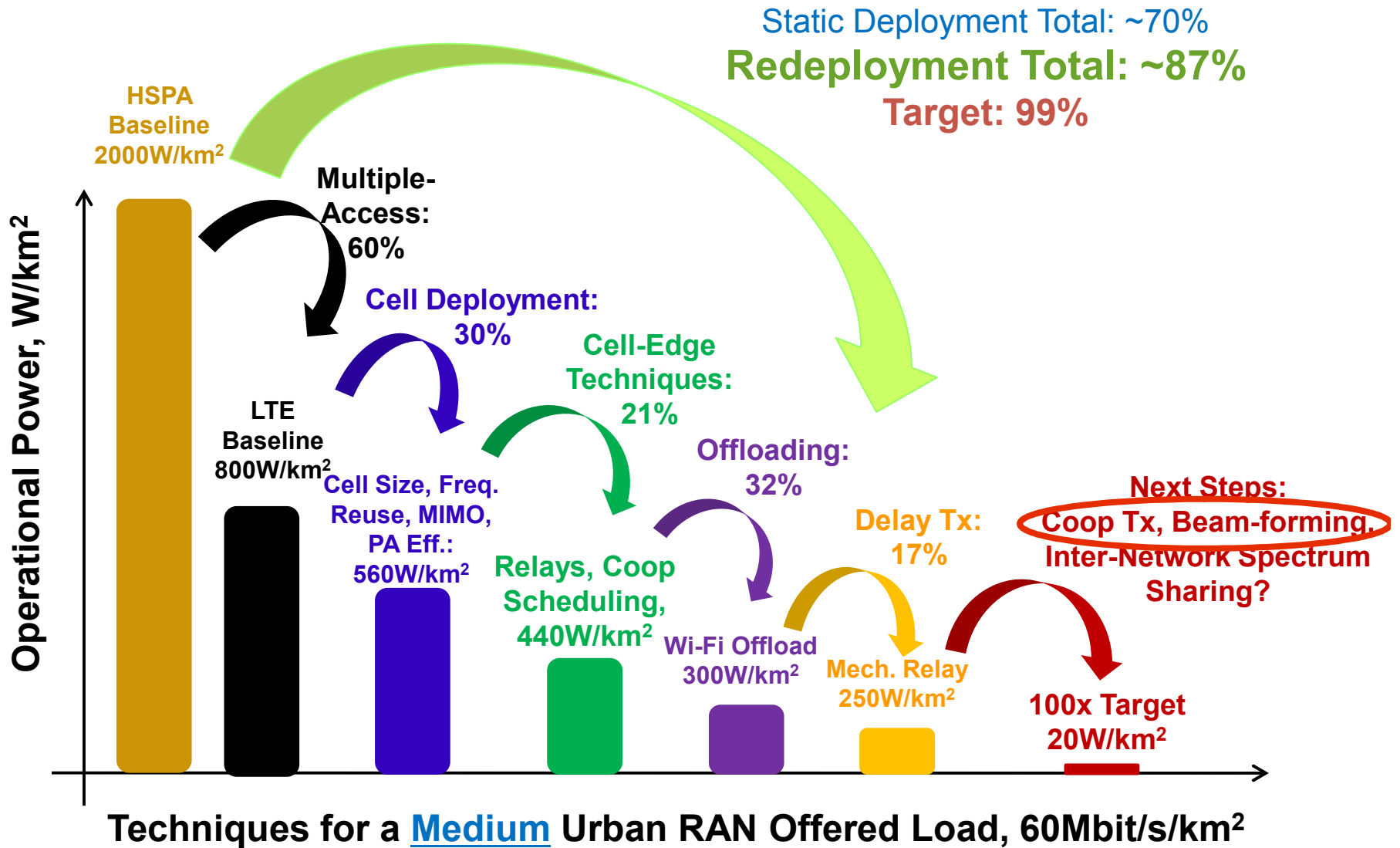


# VCE Static Deployment Integration Results

evaluated on "LTE capable" simulation platform



# VCE Redeployment Integration Results



# System Level Innovations are needed

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3GPP RAN talks about energy/power efficiency for LTE but acts on simulations showing (Area/Link/System) Spectral Efficiency gains.

- Link dB savings aren't enough.

New features are added to increase the capability of the system to report power consumption

- Proprietary interaction with O&M Systems may not reduce energy.

Sleep modes

- If you have to turn parts of a system off to make it consume less instantaneous power is this really an energy efficient system?

New Carrier Concepts in RAN1 in Rel11.....is this the start of the change (cf. R1-113495)?

# Key Metrics for Energy Use

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## Energy Consumption Ratio (ECR)

This is a measurement of a single system in Joules per bit and is simply the Energy consumed by the system divided by the number of application data bits communicated

$$\text{ECR} = \frac{\text{Energy Consumed}}{\text{Data Bits Communicated}}$$

## Energy Consumption Gain (ECG)

This compares the energy consumed by a system under test, relative to a reference system, where both communicate the same number of data bits

$$\text{ECG} = \frac{\text{Energy Consumed by Reference System}}{\text{Energy Consumed by System Under Test}}$$

An **ECG > 1** indicates an improvement in **efficiency**.

# Recent update of wish list from NGMN

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NGMN networks must aim at becoming **energy efficient** and power saving to achieve green communication. To this end, three separate areas of improvement are identified, leading to somehow separated requirements:

- **Improvement on network energy efficiency**
- **Improvement on terminal energy efficiency**
- **Reduction of the amount of waste derived by disposing of packages and used equipments**

## Continued.....

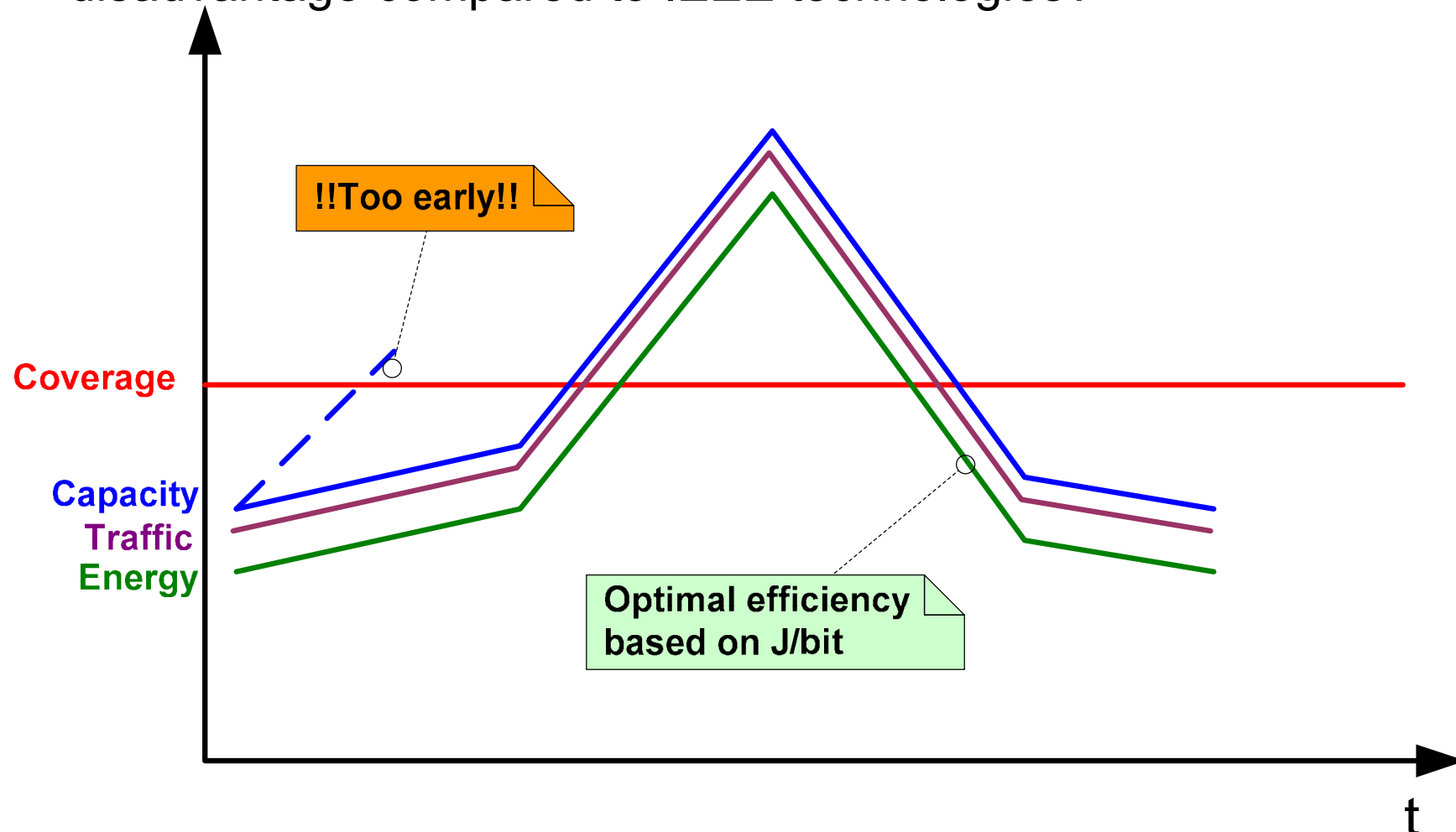
Overall **emission efficiency**, defined as the effective **transmission power divided by the total power consumed**. It should be improved to a much higher level to reduce the unnecessary power consumption in both RAN and CORE parts and the cost of power bills as well.

**Power consumption of transmitting/receiving one bit**. This will not only reflect system emission efficiency but also reflect the advantages from **using new air interface technologies**. The target figure for this KPI should be derived from the current RAN systems as well as new LTE RAN systems in near future.

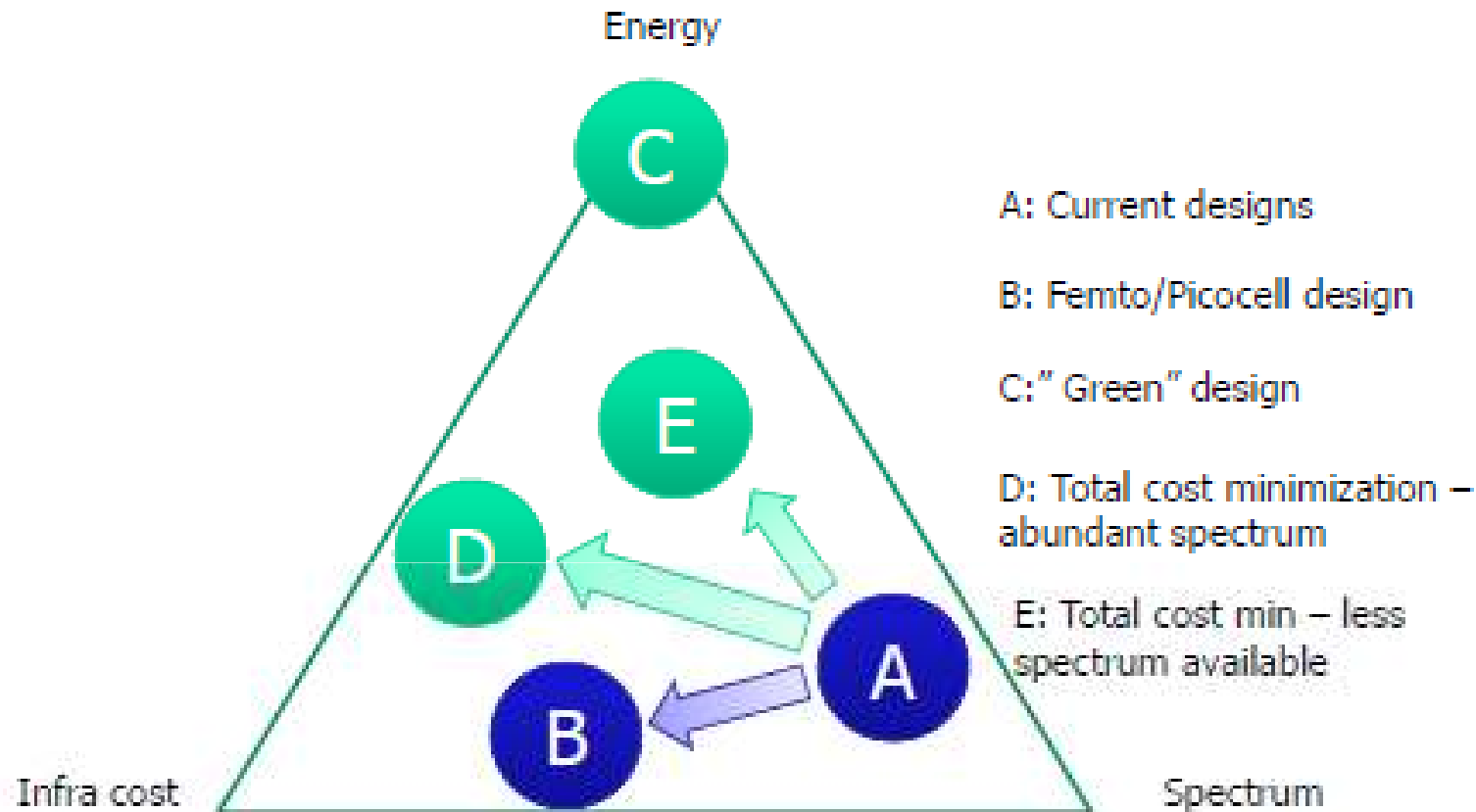
Individual major equipment power efficiency in typical environment, defined by performance vs. power. For BTS or transmit equipments, it can be defined as **average power used in transmitting/receiving one bit**. For power supply system or backup batteries, it can be defined as useful power vs. total power consumed. For air condition, it can use well-defined industry standard on power efficiency.

# Just use energy when you need it for revenue earning

Signalling is an overhead of the standard, and not good for energy accounting. Does the protocol heavy legacy of 3GPP put it at a disadvantage compared to IEEE technologies?



# When to start a re-assessment of the approach?



$$C_{tot} = C_{infra} + C_{energy} + C_{spectrum}$$

Wireless@KTH



GreenNet Workshop IEEE VTC2011 Budapest

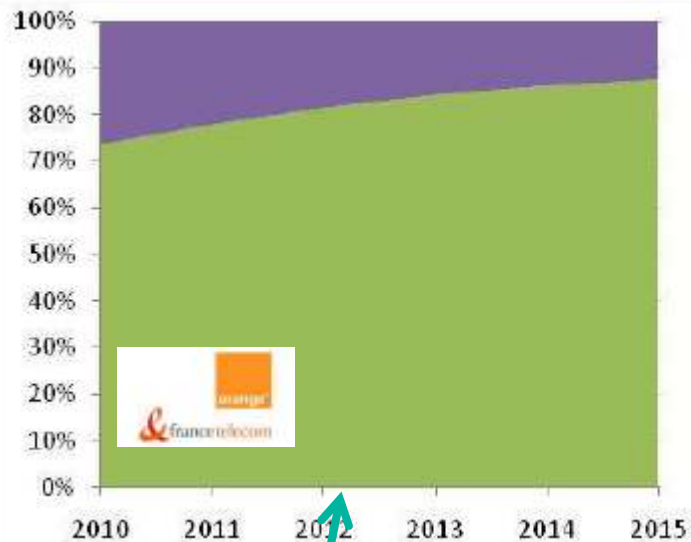
B

**VTC Spring 2012 Yokohama Call for papers open now.**

<http://vtc2012workshops.trackchair.com/track/983>



# Recent Operator statements



Mobile operator 3UK has announced that **97%** of all the traffic travelling through its network today is **data**. The carrier added that in the 14 months between June 2010 and September 2011, it has seen a 427 per cent increase in data usage for smartphone customers. [Informa, Dec'2011]



## “Green” requirements for small cells

- Shut down of small cells when not needed for capacity
- Rapid, but smooth, power-up facility required if traffic increases unexpectedly
- Sleep mode required with low power wideband receiver to detect approaching UEs and trigger wake-up of BTS



Bath basestation conference in Sept'2011

# Small cells **must be** turned off to avoid energy waste

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- Network sharing and best connect propositions need to be clear.
  
- Operator expectations that show a ~3sec power up capability which may challenge existing protocols
  - mechanism to wake up the cell needs to be standardised?
  - Low power RF detector or macro layer coverage?
  
- Relays may be deployed with alternative energy sources, keep the average and peak power consumption within tightly defined region, power density (W/km<sup>2</sup>)

# Techniques that are emerging from Research

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Ideas are now being discovered in Research that will need to be studied in the pre-standardisation groups of companies for potential 3GPP (and other bodies) impact.

The following are already on the candidate list:

- Random Network Coding (Layer2)
- Cognitive and Spectrum agile methods (Carrier Aggregation++)
- Delay Tolerant Networking (cross layer)
- “Neural nets” (U-Plane edge optimal routing)

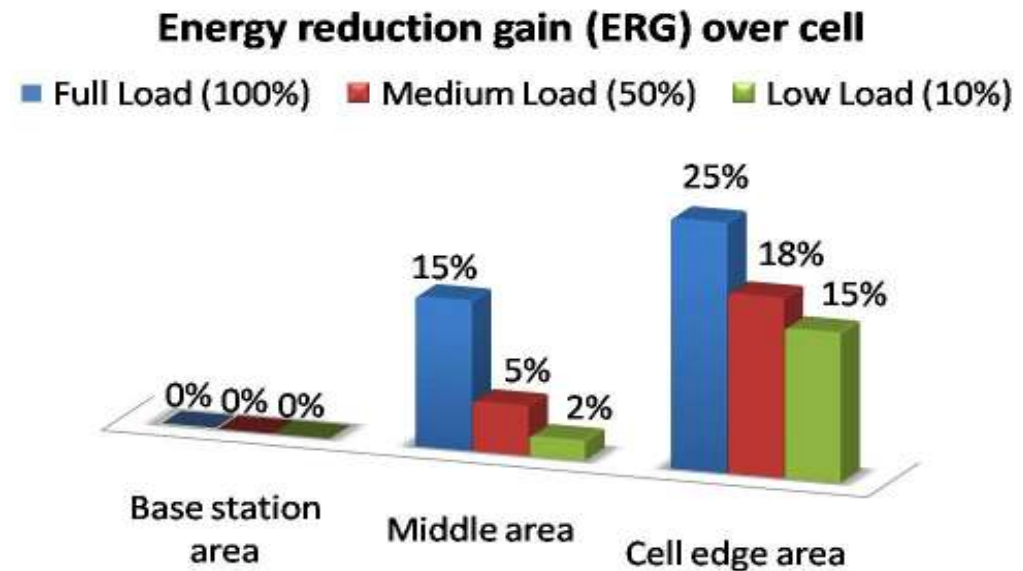
# Random Network Coding (R-NC)



- ❑ R-NC is a rateless code alternative to HARQ in LTE
- ❑ Downlink data is transmitted to the terminal until the data is decoded and ACK received

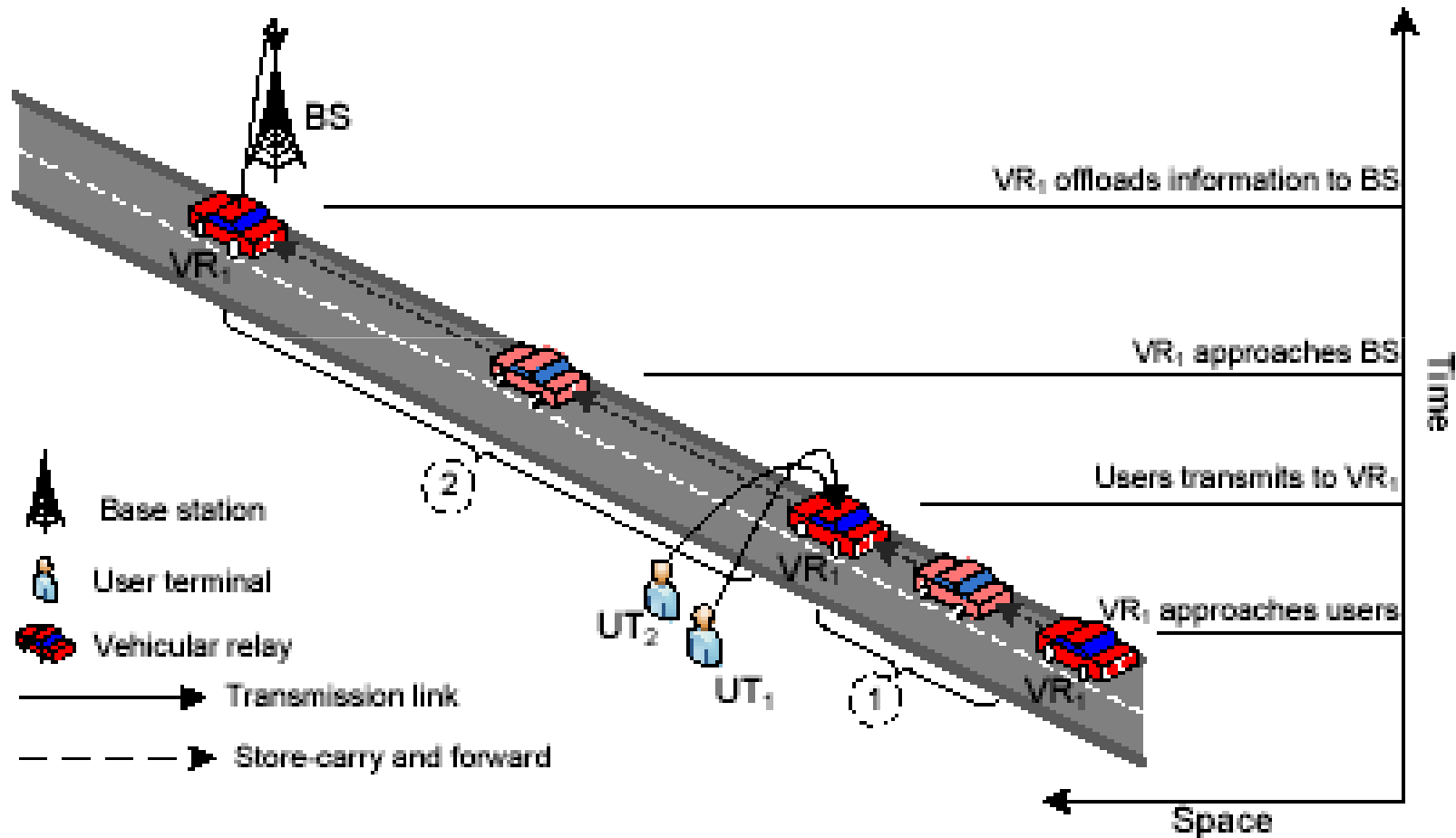
## Claimed Key Advantages:

- ❑ Reduced Delay
- ❑ Lower signalling
- ❑ Better Robustness in Fast Fading Scenarios



# Delay Tolerant Networking

## GR label: Mechanical Relay



# The journey continues

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## ■ Culture change of standards design

- Enabling the system level assessment of the energy efficiency of innovations that should be standardised.

**LTE Rel11 is establishing some of the platforms (relay/RRH etc.) BUT it is possible to construct an Energy Inefficient System from this Standard.**

## ■ This is just the start

■ The 10year transformation of RAN toward **5G** is now starting

■ Custom carrier for targeted requirements on multi-standard carrier capable platforms

■ **Release 12/13** prioritisation discussions starting now

## ■ Political priorities are debt burden .....at the moment

■ There will be a consensus for models of ICT equipment that may be used by Standards bodies to verify their innovations for **CO2 impact**.

Empowered by Innovation

**NEC**