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eMBMS

Technical challenges and possible solutions

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What is (e)MBMS?

(evolved) Multimedia Broadcast Multicast Service

Technological context

- Main advantages over technologies as DVB-H or DMB

  - No additional infrastructure

  - Operator uses resources that are already purchased

  - User interaction is possible

Transmission

- Two transmission schemes

  - Single-cell transmission

    – Each cell is served individually

  - Multi-cell transmission

    – Multiple contiguous cells are covered synchronously such that signals from several cells are perceived as one signal by the terminal

    – Such synchronized cells form a so-called MBSFN area (MBMS single frequency network area) that is service-specific.

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What is MBMS?

MBMS logical architecture (3GPP TS 36.300)
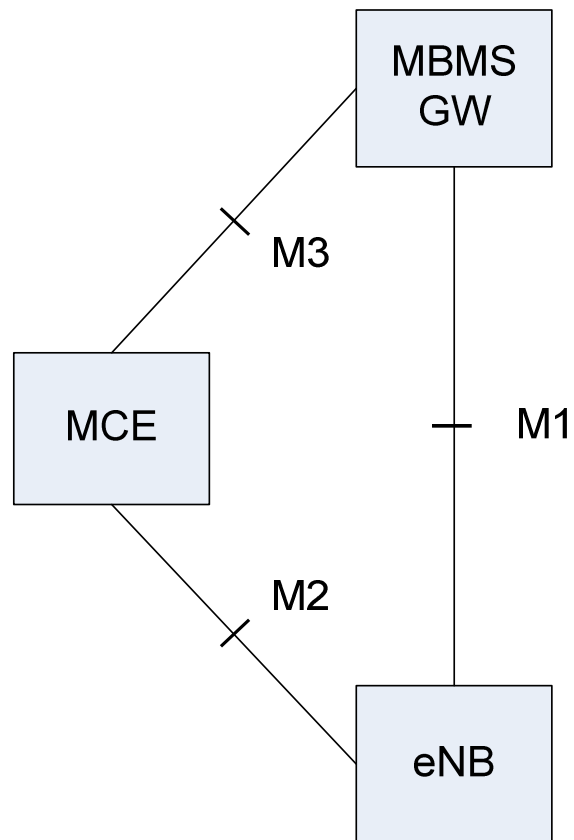
MBMS GW: MBMS Gateway
MCE: Multi-Cell/Multicast Coordination Entity

M1: user plane interface
M2: E-UTRAN internal control plane interface
M3: control plane interface between E-UTRAN and EPC

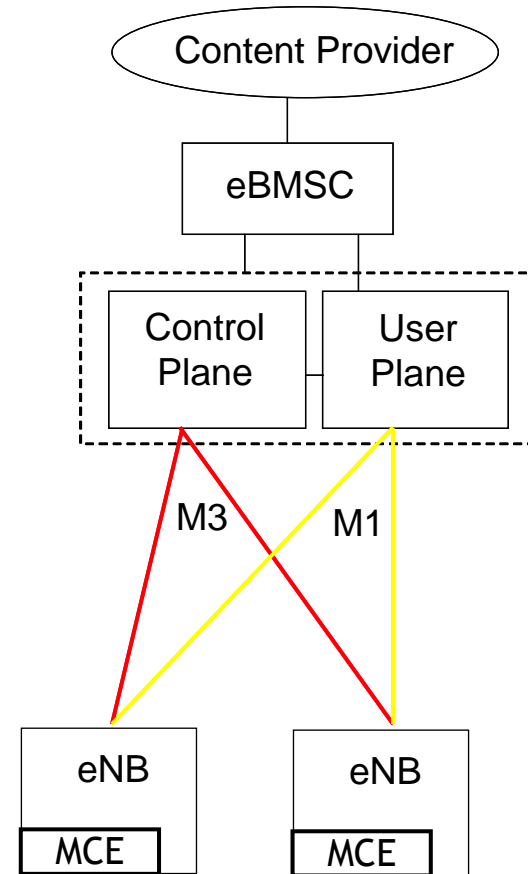**The MCE can physically be part of the eNB
→ flat architecture**

The MCE coordinates the synchronous multi-cell transmission

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What is MBMS?

MBMS architecture deployment alternatives (TS 36.300)

Content Provider

eBMSC

Control Plane | User Plane

M3

MCE

M1

M2

eNB | eNB
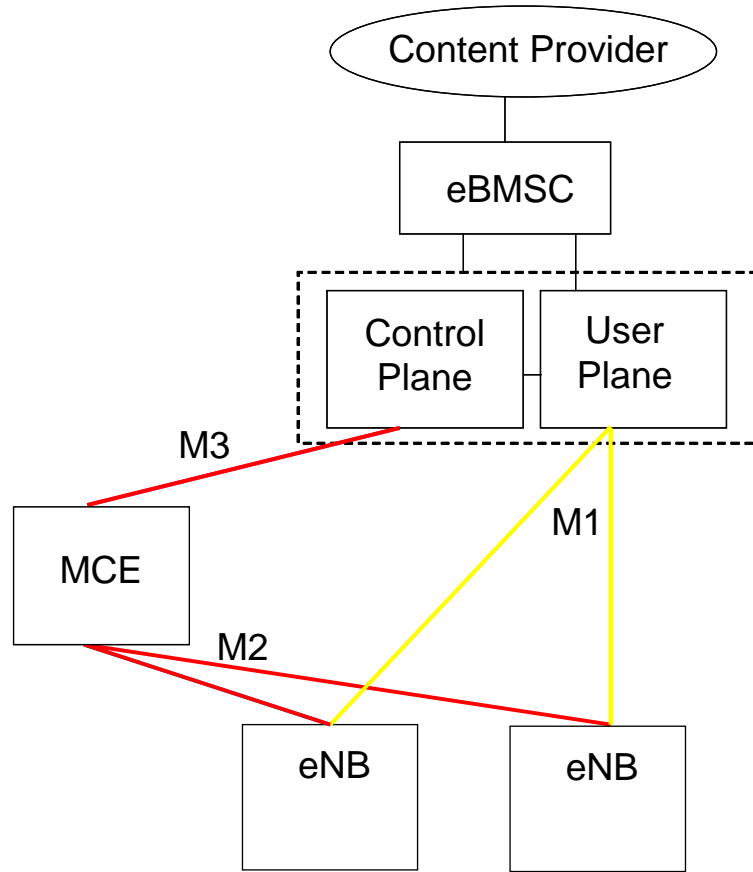
Hierarchical architecture

Content Provider

eBMSC

Control Plane | User Plane

M3 | M1

eNB | eNB

MCE | MCE

Flat architecture

With the flat architecture a software upgrade is sufficient for the radio access network
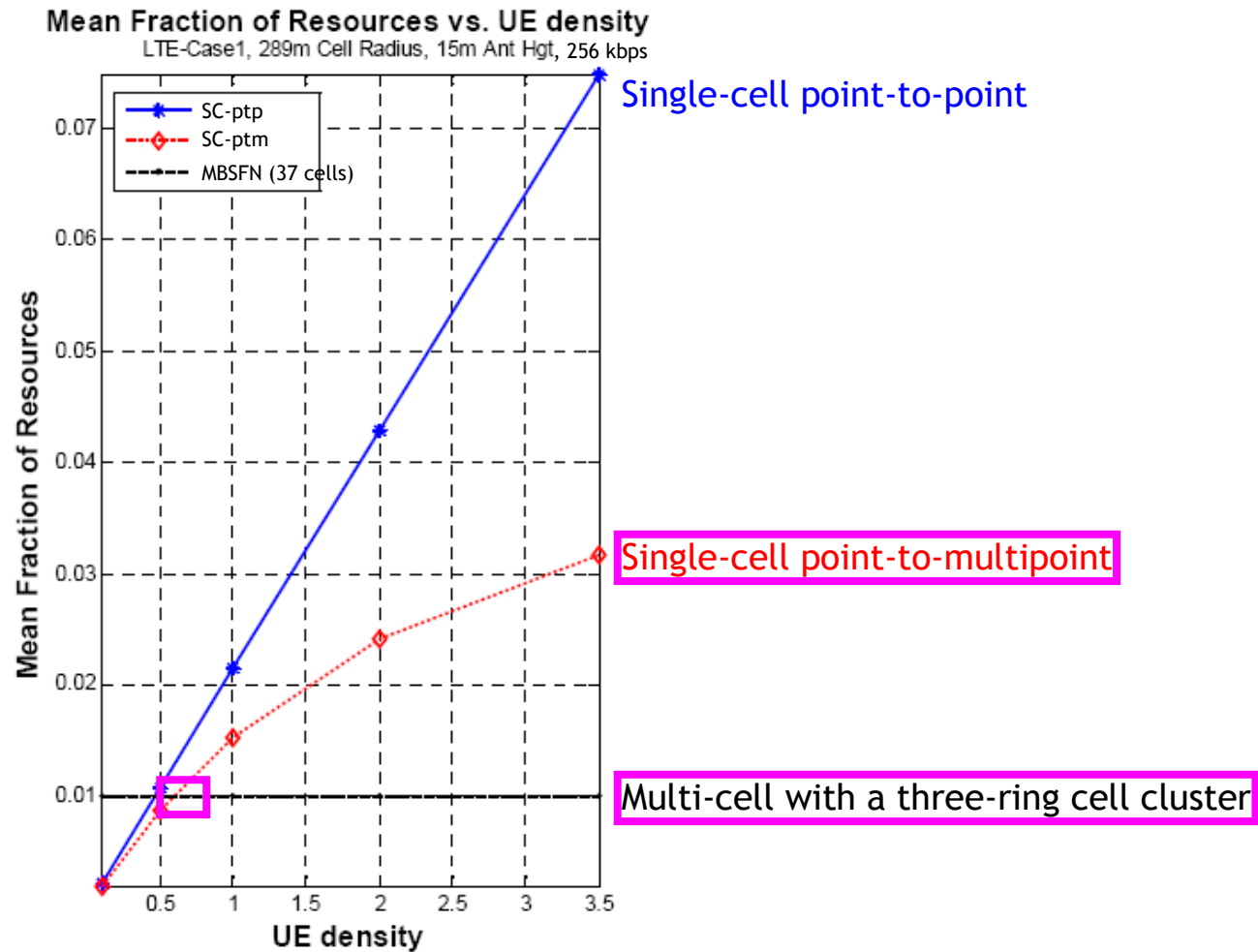
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Single-cell or multi-cell transmission?
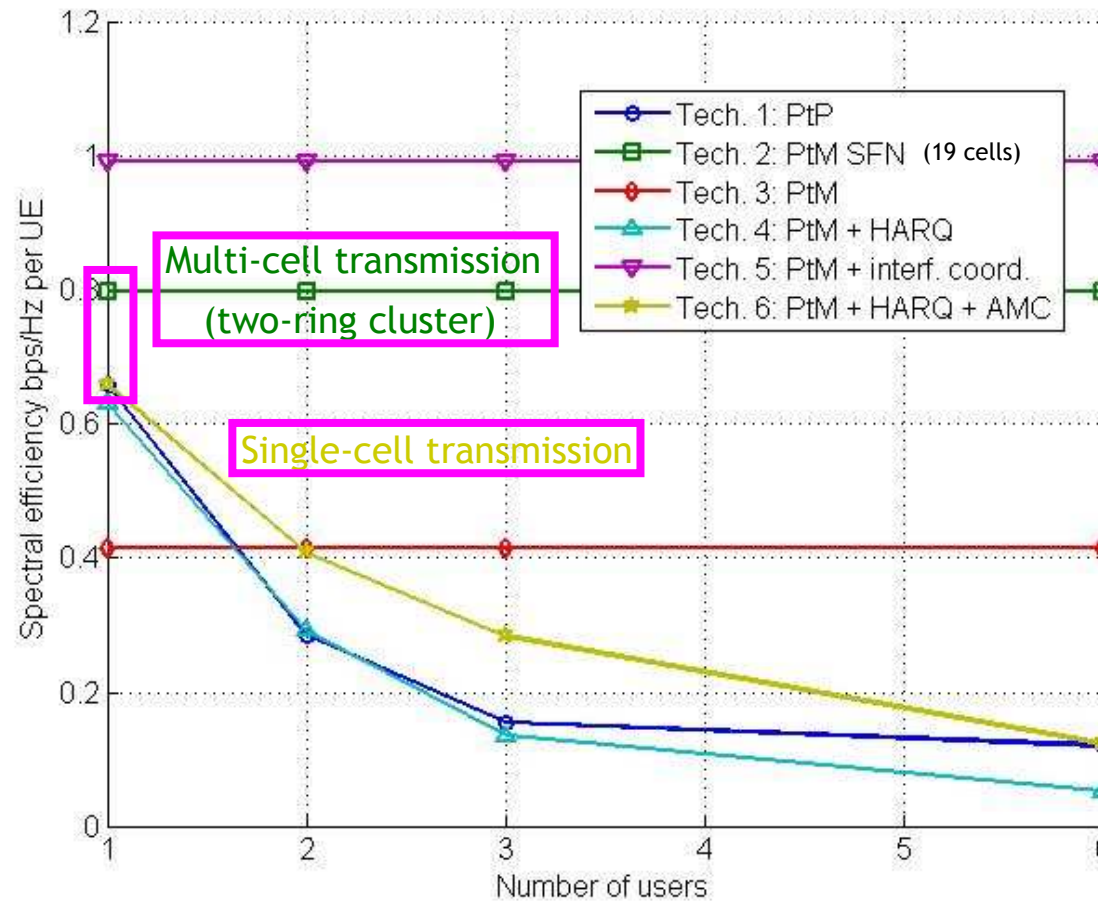
Single-cell or multi-cell transmission?

Simulation results by Motorola assuming Poisson distribution of users (R1-071433)

Mean Fraction of Resources vs. UE density
LTE-Case1, 289m Cell Radius, 15m Ant Hgt, 256 kbps

Legend:
- SC-ptp
- SC-ptm
- MBSFN (37 cells)

Single-cell point-to-point

Single-cell point-to-multipoint

Multi-cell with a three-ring cell cluster

(Y-axis: Mean Fraction of Resources — 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07)
(X-axis: UE density — 0.5, 1, 1.5, 2, 2.5, 3, 3.5)

MBSFN transmission is more efficient than SC-ptm transmission for at least **0.6 users/cell**.

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Single-cell or multi-cell transmission?

Simulation results by Nokia (R1-070984)

MBSFN transmission is more efficient than SC-ptm transmission for at least **1 user/cell**.

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Single-cell or multi-cell transmission?

User density can be determined by polling or by counting (R2-072657)
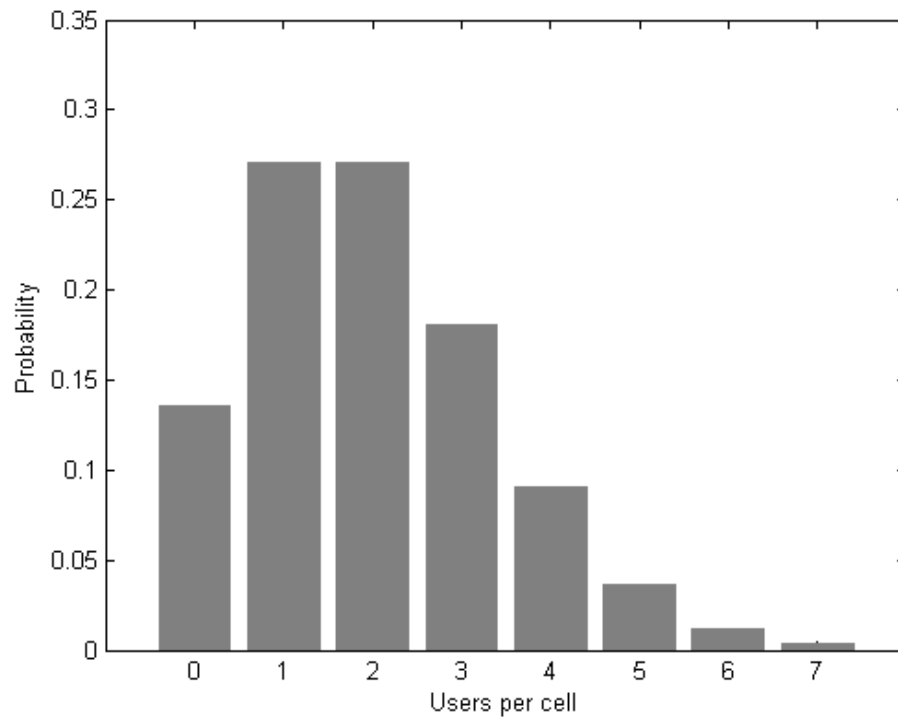
- Counting: Determine **how many** interested users there are for the given service ⟵ expensive

- Polling: Determine **if** there is an interested user for the given service ⟵ inexpensive

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Single-cell or multi-cell transmission?

User density can be determined by polling or by counting (R2-072657)

- Counting: Determine **how many** interested users there are for the given service → expensive

- Polling: Determine **if** there is an interested user for the given service → inexpensive

Poisson distribution of the number of users per cell for an expectation value of 2 users/cell

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Single-cell or multi-cell transmission?

User density can be determined by polling or by counting (R2-072657)

- Counting: Determine **how many** interested users there are for the given service ⟵ expensive

- Polling: Determine **if** there is an interested user for the given service ⟵ inexpensive
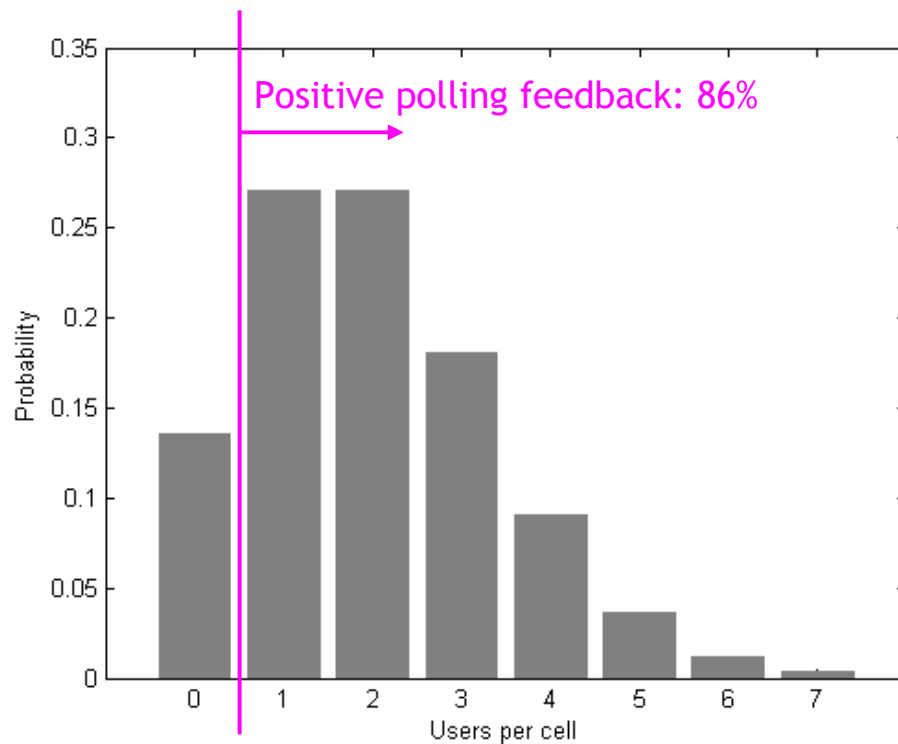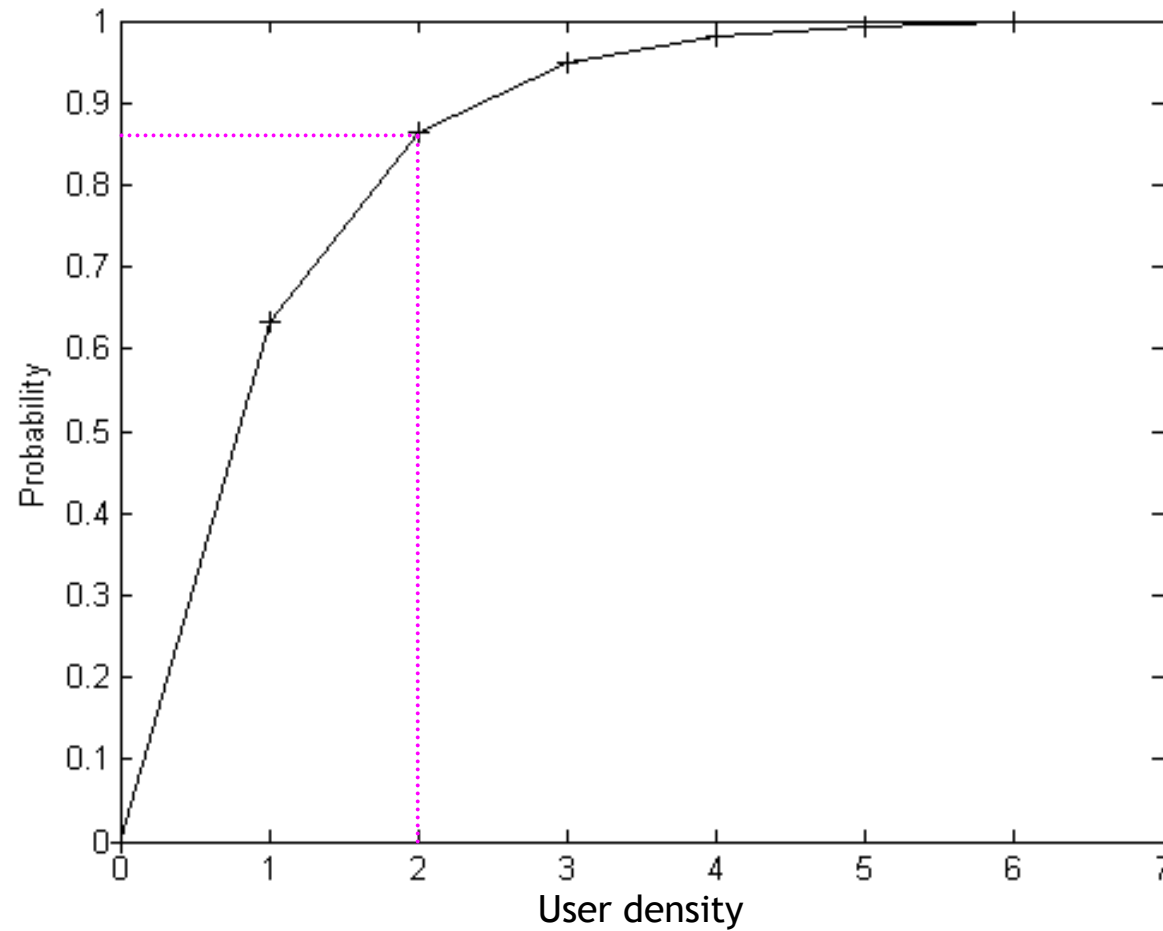
Positive polling feedback: 86%

Probability / Users per cell

Poisson distribution of the number of users per cell for an expectation value of 2 users/cell

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Single-cell or multi-cell transmission?

Polling information for a cell cluster implicitly contains counting information (R2-072657)

Probability distribution of having **at least one** user in a cell against the average user density

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Single-cell or multi-cell transmission?

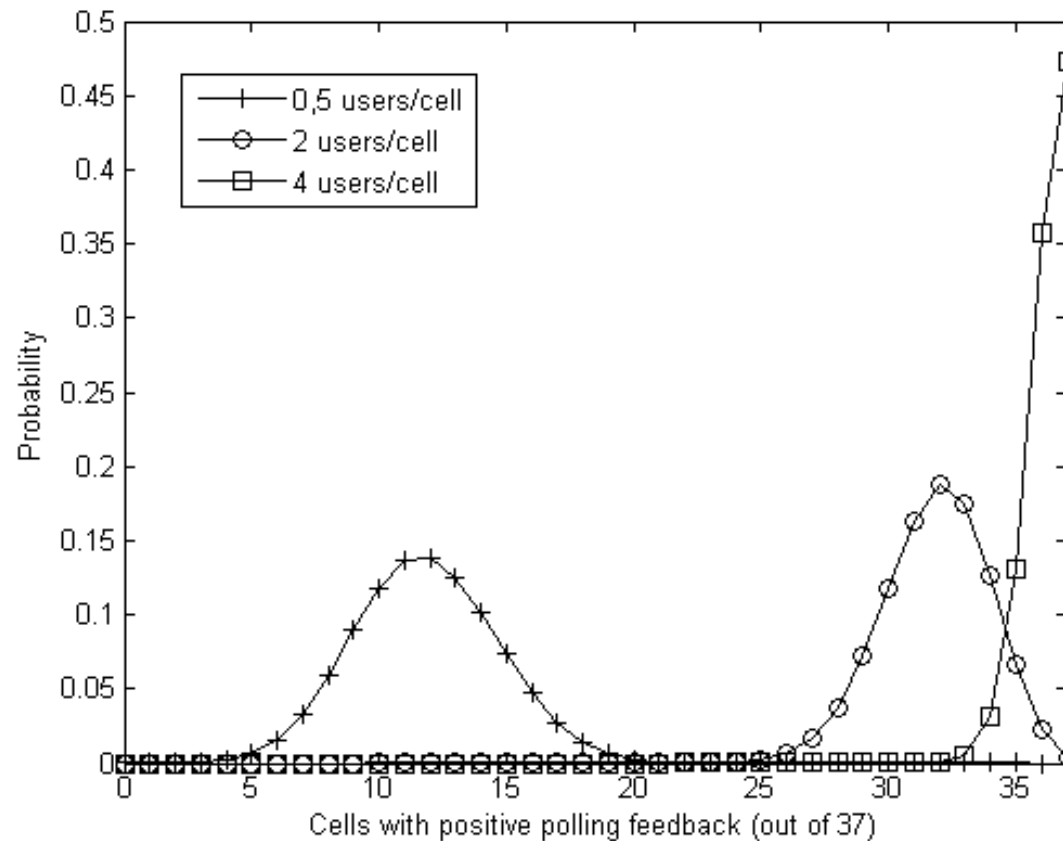## Polling information for a cell cluster implicitly contains counting information (R2-072657)

Number of cells with positive polling feedback in a three-ring cell cluster with 37 cells
for three different user densities

Polling is sufficient to determine user density

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Single-cell or multi-cell transmission?

Transmission mode depending on used resources (R2-072662)

- Average user density could be the key criterion for the MCE which transmission mode to use

  BUT

- Efficiency of radio resources should be the main focus!

  → It would be more suitable for an eNB to send an estimate of the achievable transmission efficiency instead of polling/counting information

  - Measure could be e.g. used resource blocks per data quantity

MCE

Estimate of used radio resources for given MBMS service
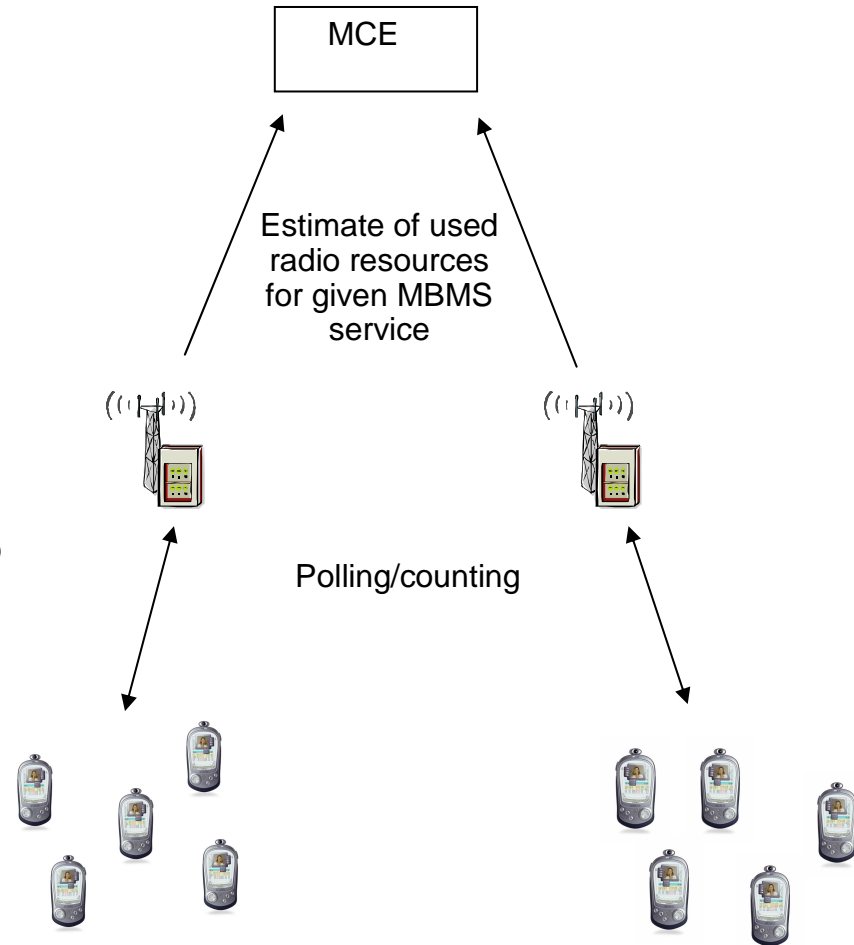
Polling/counting

MCE should be informed about used resources rather than polling/counting information.
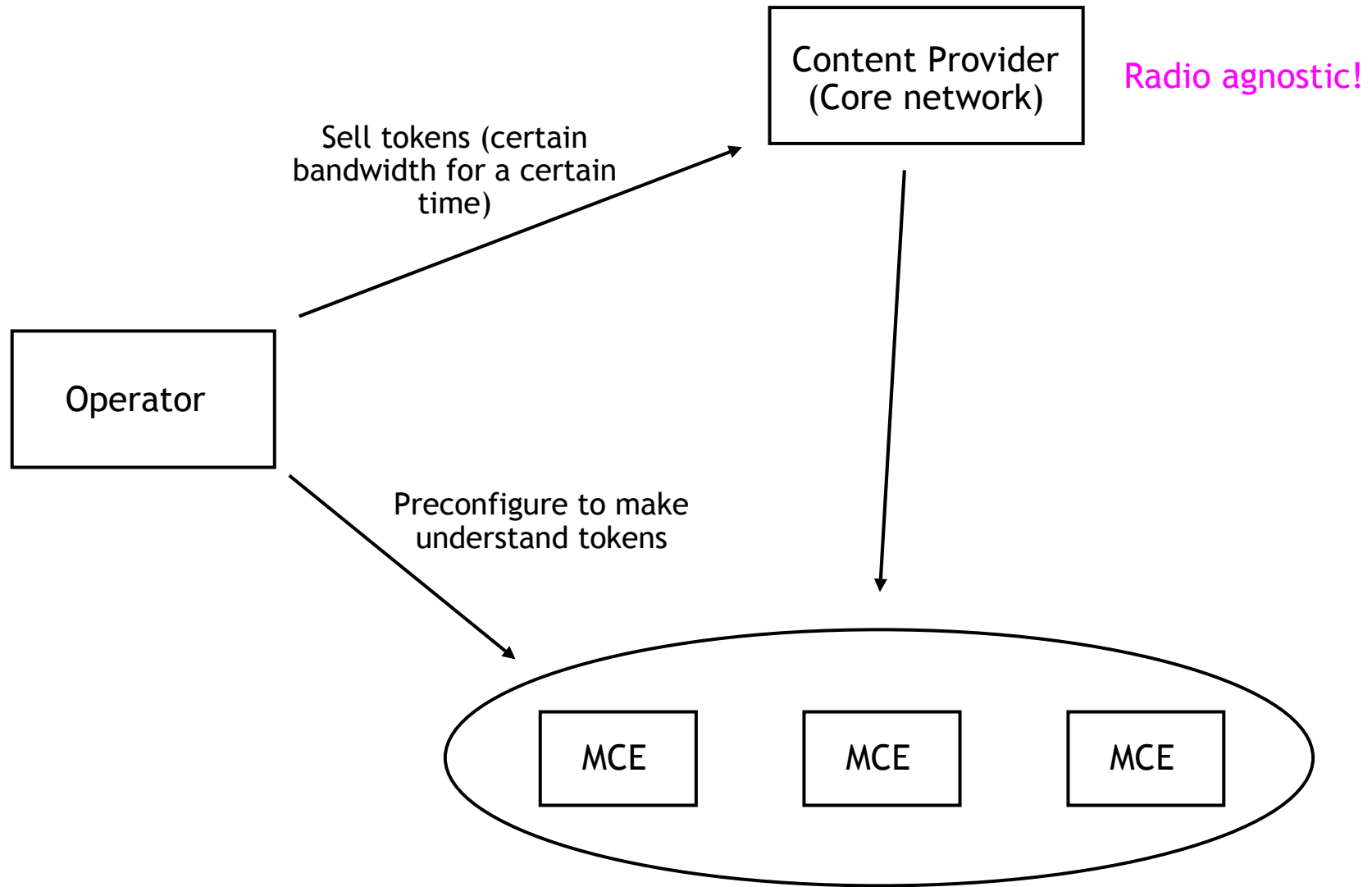
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Coordination of base stations in single frequency networks

Coordination of MCEs in the flat architecture

Coordination by the core network using tokens (R3-071452)

Content Provider
(Core network)

Radio agnostic!

Sell tokens (certain bandwidth for a certain time)
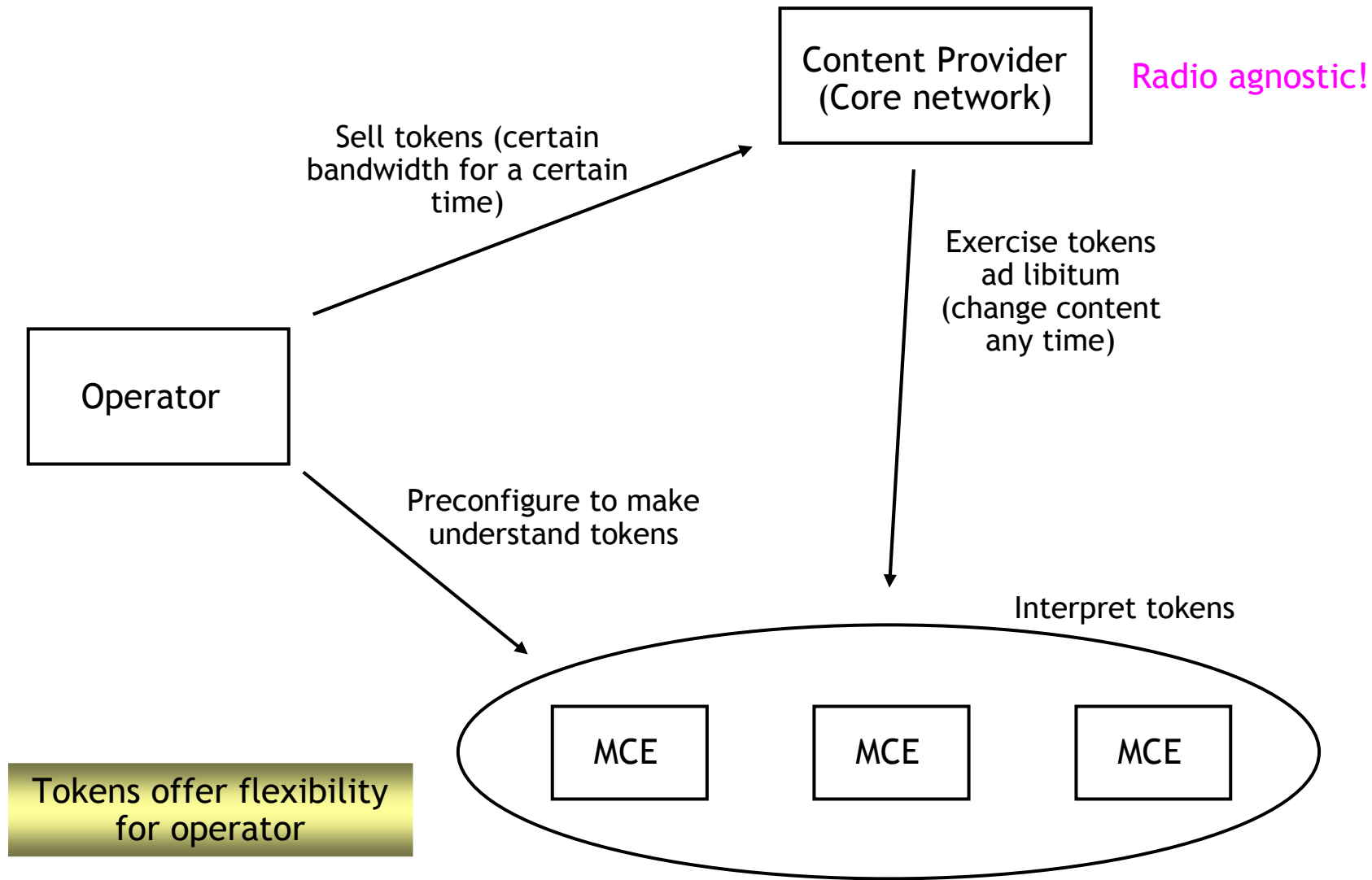
Operator

Preconfigure to make understand tokens

MCE   MCE   MCE

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Coordination of MCEs in the flat architecture

Coordination by the core network using tokens (R3-071452)

Content Provider
(Core network)

Radio agnostic!

Sell tokens (certain bandwidth for a certain time)

Exercise tokens ad libitum (change content any time)

Operator

Preconfigure to make understand tokens

Interpret tokens

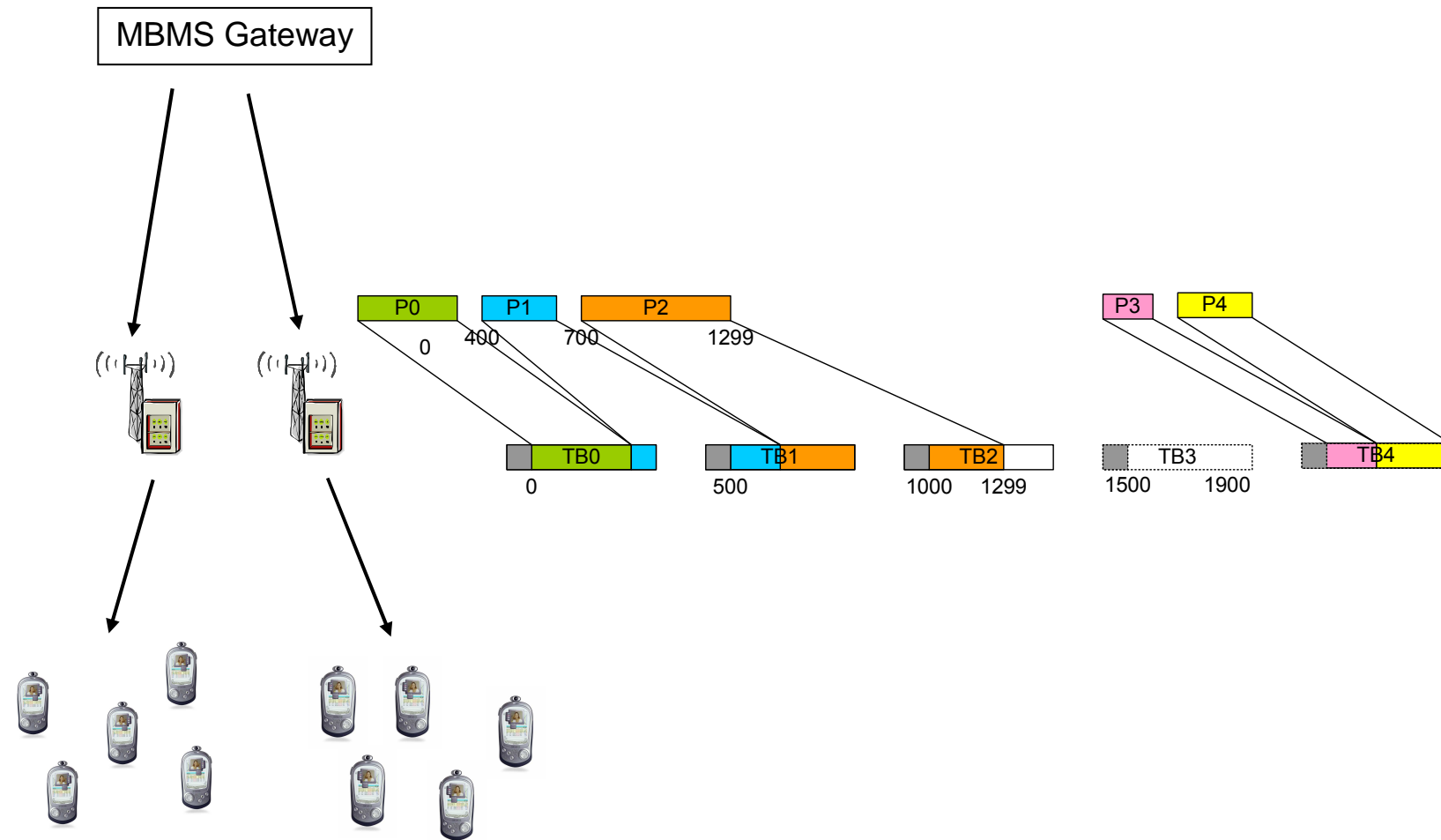MCE   MCE   MCE

Tokens offer flexibility for operator

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Synchronization of content

Synchronization of content

Timing for radio frame transmission and detection of packet loss

MBMS Gateway

P0   P1   P2   P3   P4

0   400   700   1299

TB0   TB1   TB2   TB3   TB4

0   500   1000   1299   1500   1900

Different packet size on radio interface

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Synchronization of content

Timing for radio frame transmission and detection of packet loss

MBMS Gateway

Lost

| P0 | P1 | P2 | | P3 | P4 |

0   400   700   1299

| TB0 | TB1 | TB2 | | TB3 | | TB4 |

0   500   1000   1299   1500   1900

Not transmitted

Next packet is okay
thanks to byte counter

Robustness with
respect to packet loss
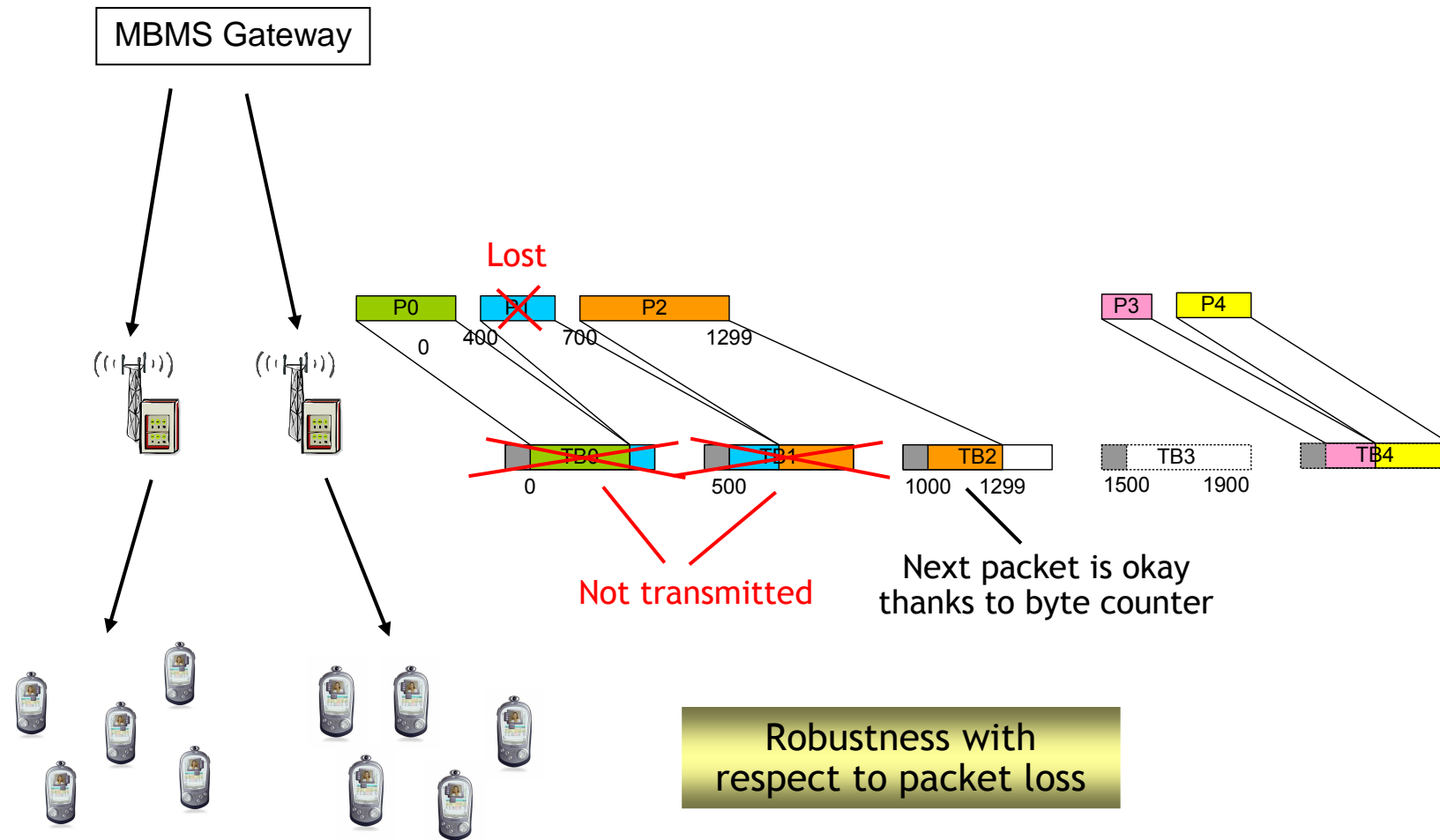
Synchronization utilizes time stamps, sequence numbers, and byte counters

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Conclusion

Conclusion

Key challenges and key solutions

- Single-cell or multi-cell transmission?

  → The user density is related to the efficiency of the transmission mode

  → Polling is sufficient to determine the user density

  → eNB provides the MCE with information it really needs: used resources for a service

- Coordination of base stations in single frequency networks

  → Token approach facilitates the setting of common rules for all MCEs

- Synchronization of content

  → Synchronization based on time stamps, packet sequence numbers, and byte counters

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