Cellular Fundamentals 4: Basic Cellular Operation

- Mobile Initialisation
- Mobile Originated Call
- Mobile Call Reception
- Power Control
- Handoff

Review of Previous Lectures

- Traffic Intensity
- Erlang B Formula/Table
- Trunking Efficiency

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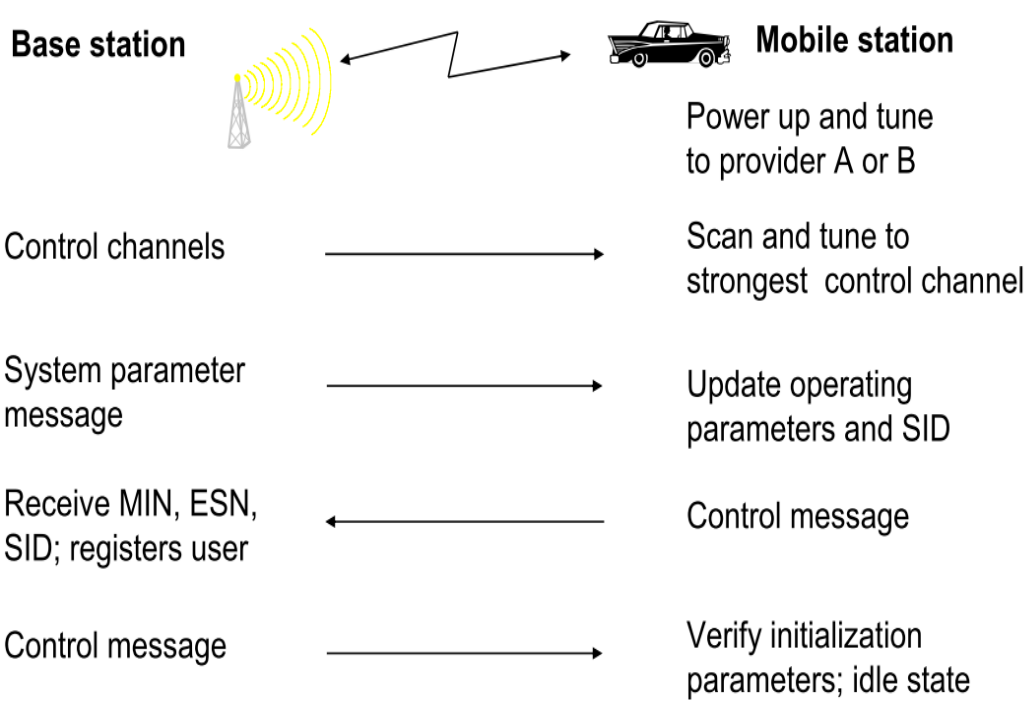
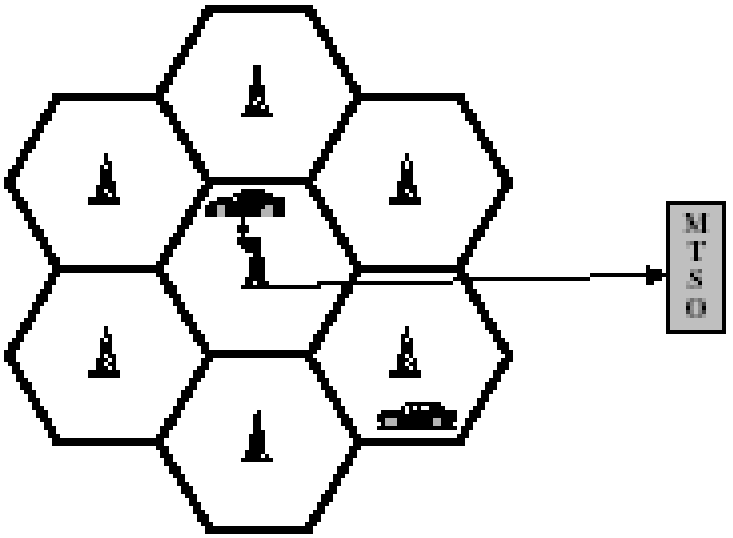
Basic Cellular Operation – Mobile Initialisation

- When the MS is turned on, it must select the strongest FOCC
- Cells with different frequency bands repetitively broadcast on different FOCCs
- The broadcasted information identifies the cellular system and the number of the access and paging channels
- After reading successfully the information on the FOCC, a handshake takes place between the MS and the MSC, identifying the MS and registering its location (Home or Roaming)
- The MS enters in the *idle* state and periodically updates system and access information
- If the MS could not perform these tasks, it must select a second strongest FOCC and try to perform the tasks above
- If after 3 seconds the MS still cannot select a FOCC and perform the tasks - NO SERVICE



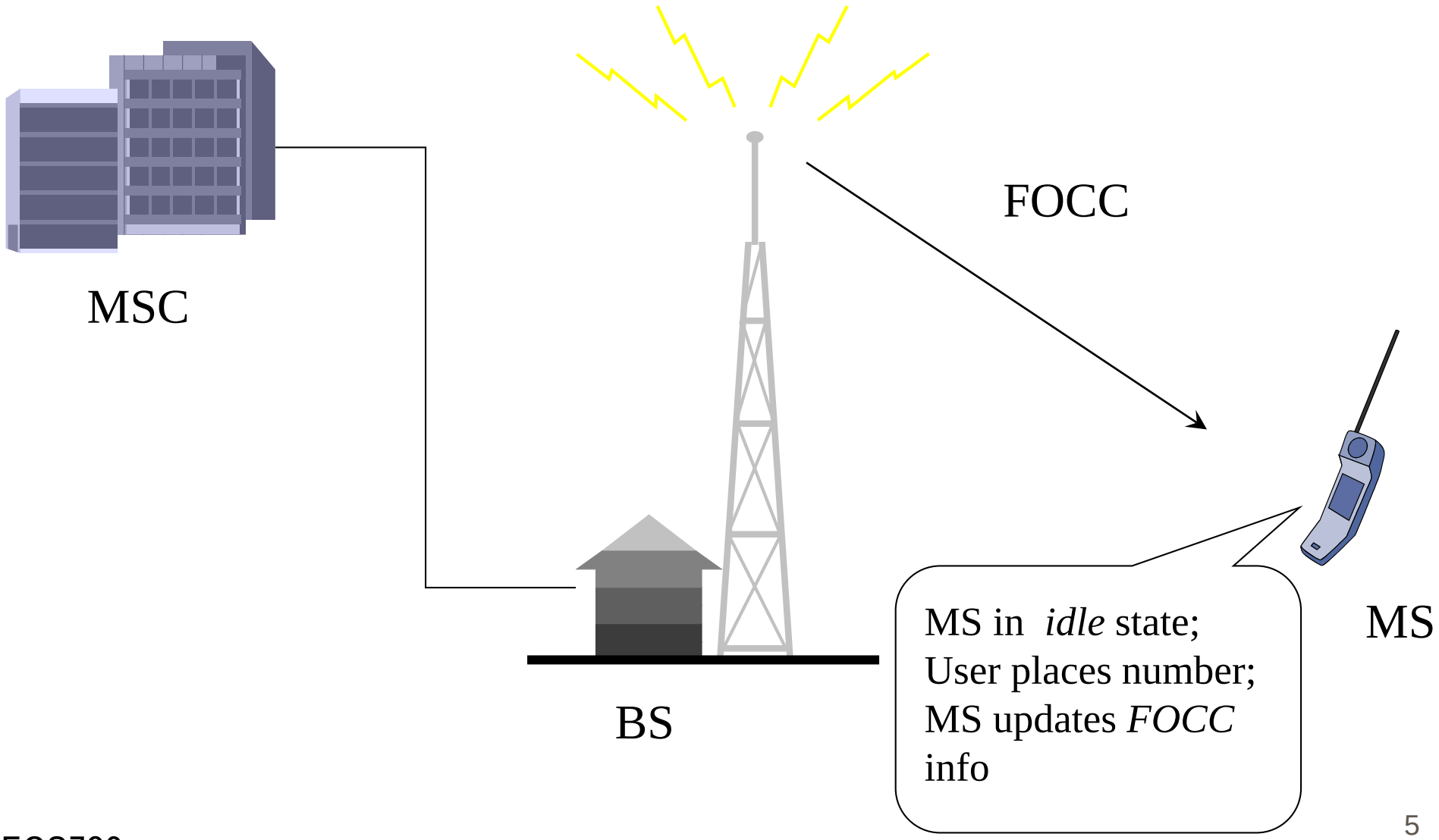
Basic Cellular Operation – Mobile Originated Call

- Pre conditions:
  - MS is in the idle state
  - User has placed the called number
- A request for connection must be sent to the network
- The MS needs to access the RECC to be able to place the request
- Random access method
- First access method (AMPS)
  - DSMA (digital or data sense multiple access)
    - BIS (BIS bit is inserted each 10bit word – 1kbps) read on FOCC
      - BIS = 0: RECC is busy, delay 0-200ms; or after max. failures, initializing new FOCC.
      - BIS = 1: RECC is idle, waiting for connection

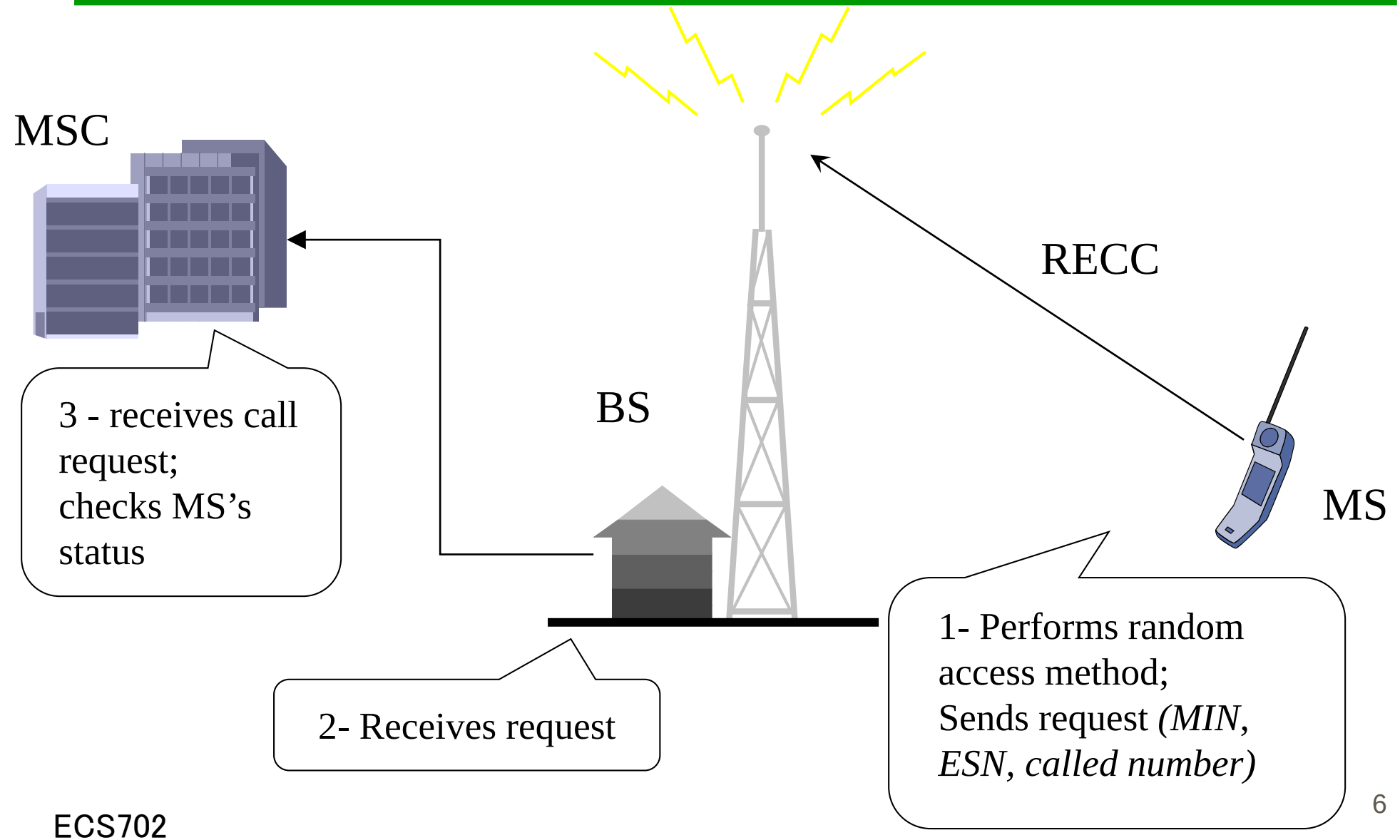


(b) Request for connection

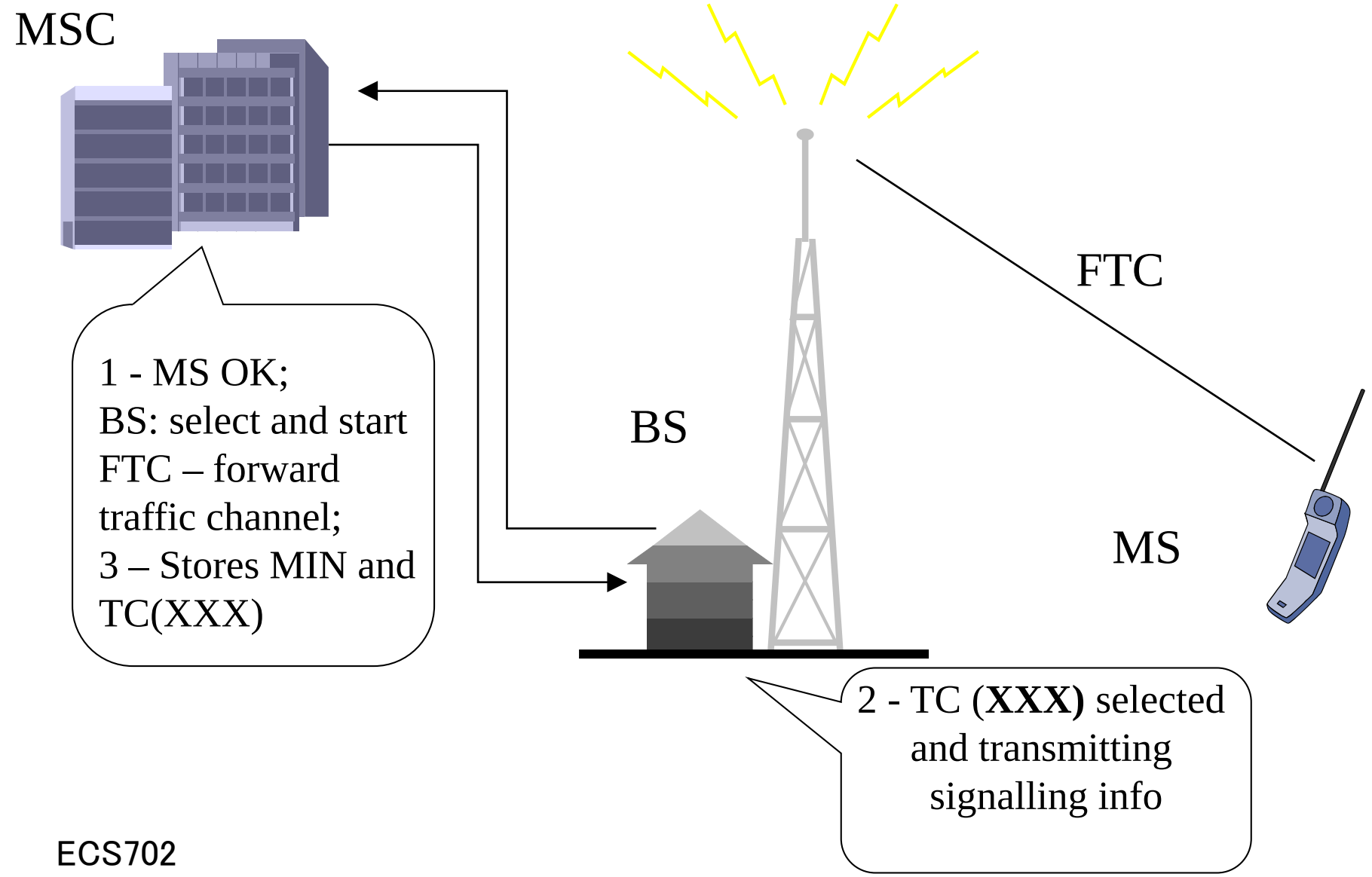
Basic Cellular Operation – Mobile Originated Call (step 1)



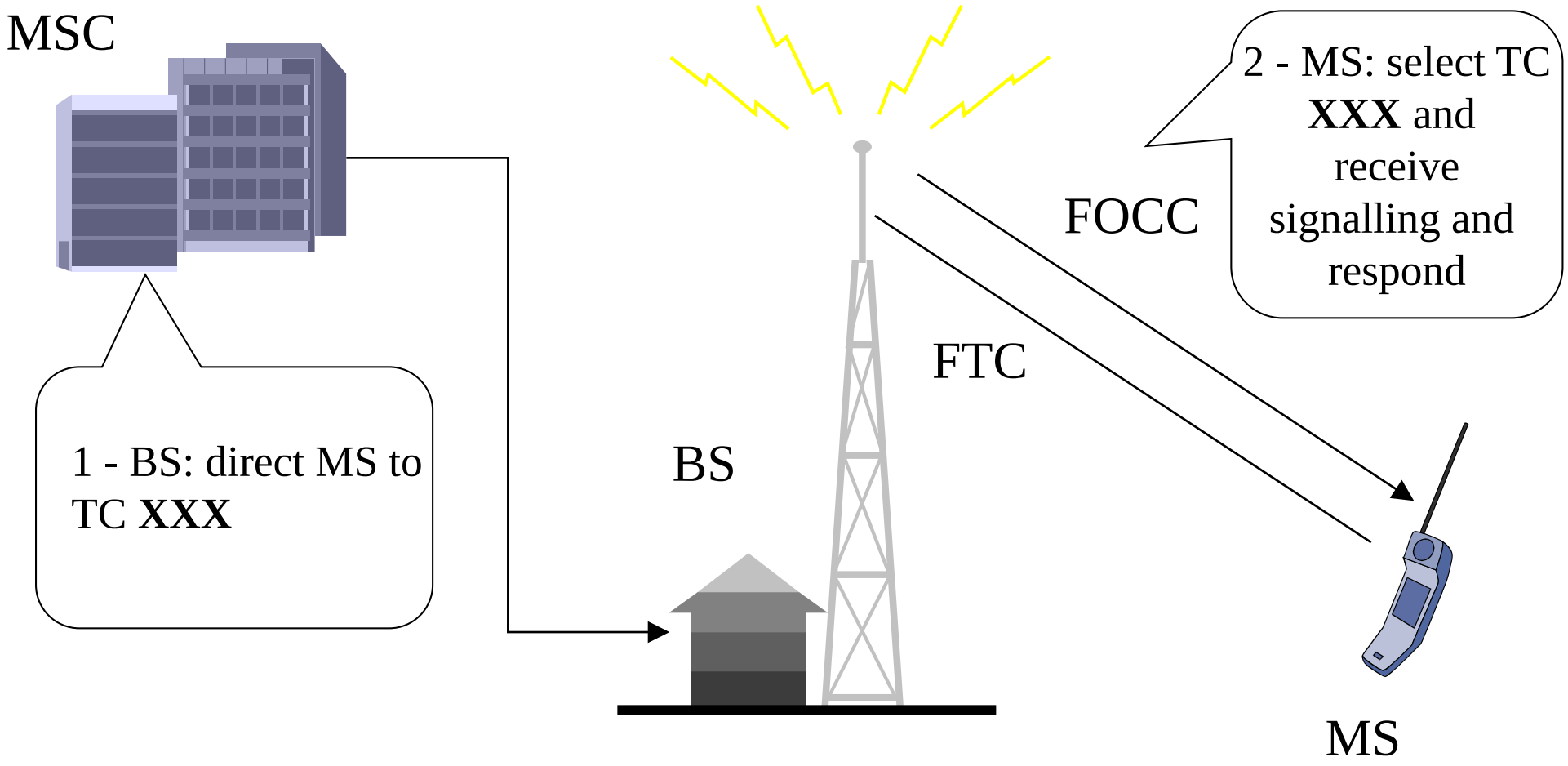
Basic Cellular Operation – Mobile Originated Call (step 2)



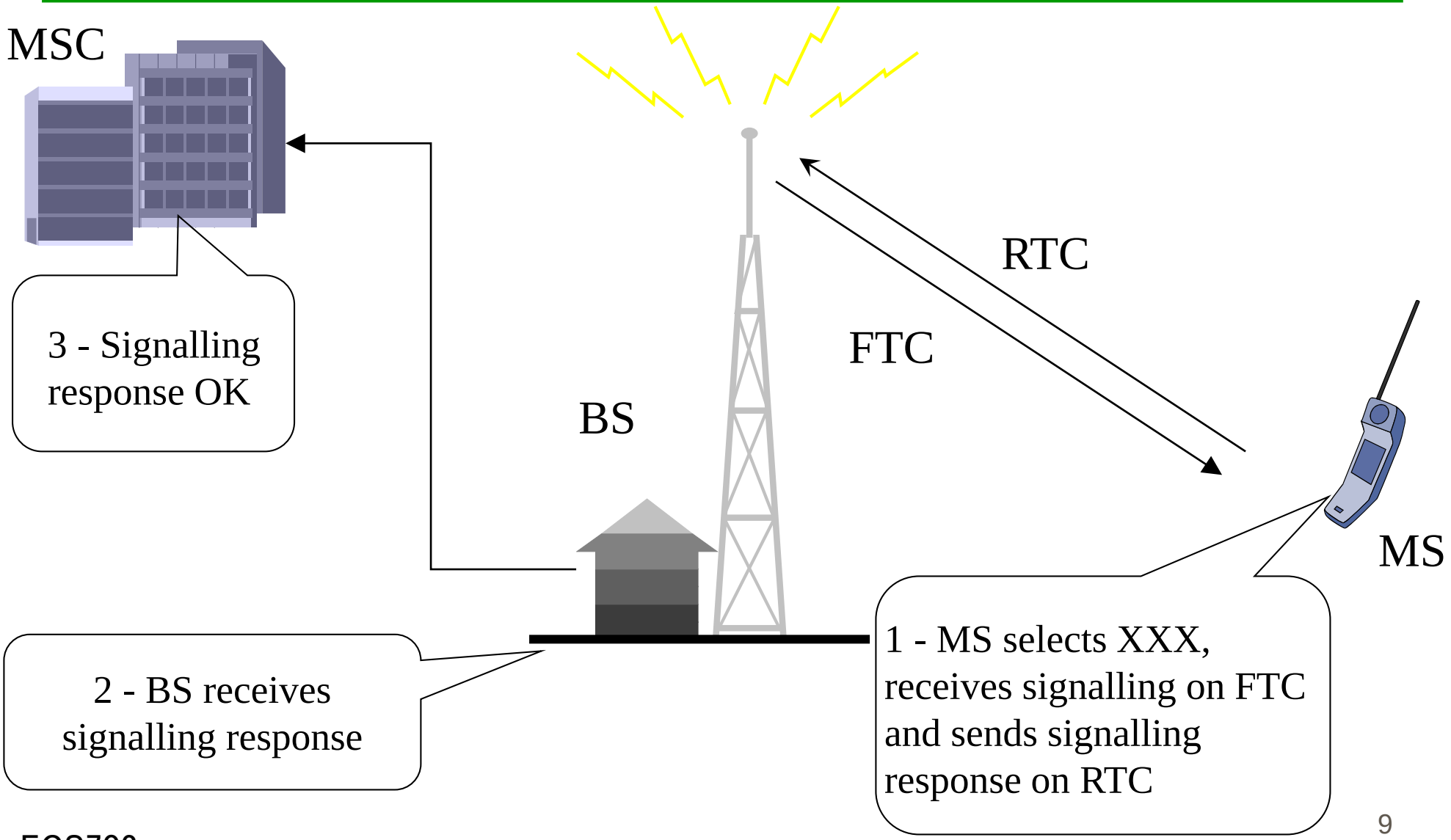
Basic Cellular Operation – Mobile Originated Call (step 3)



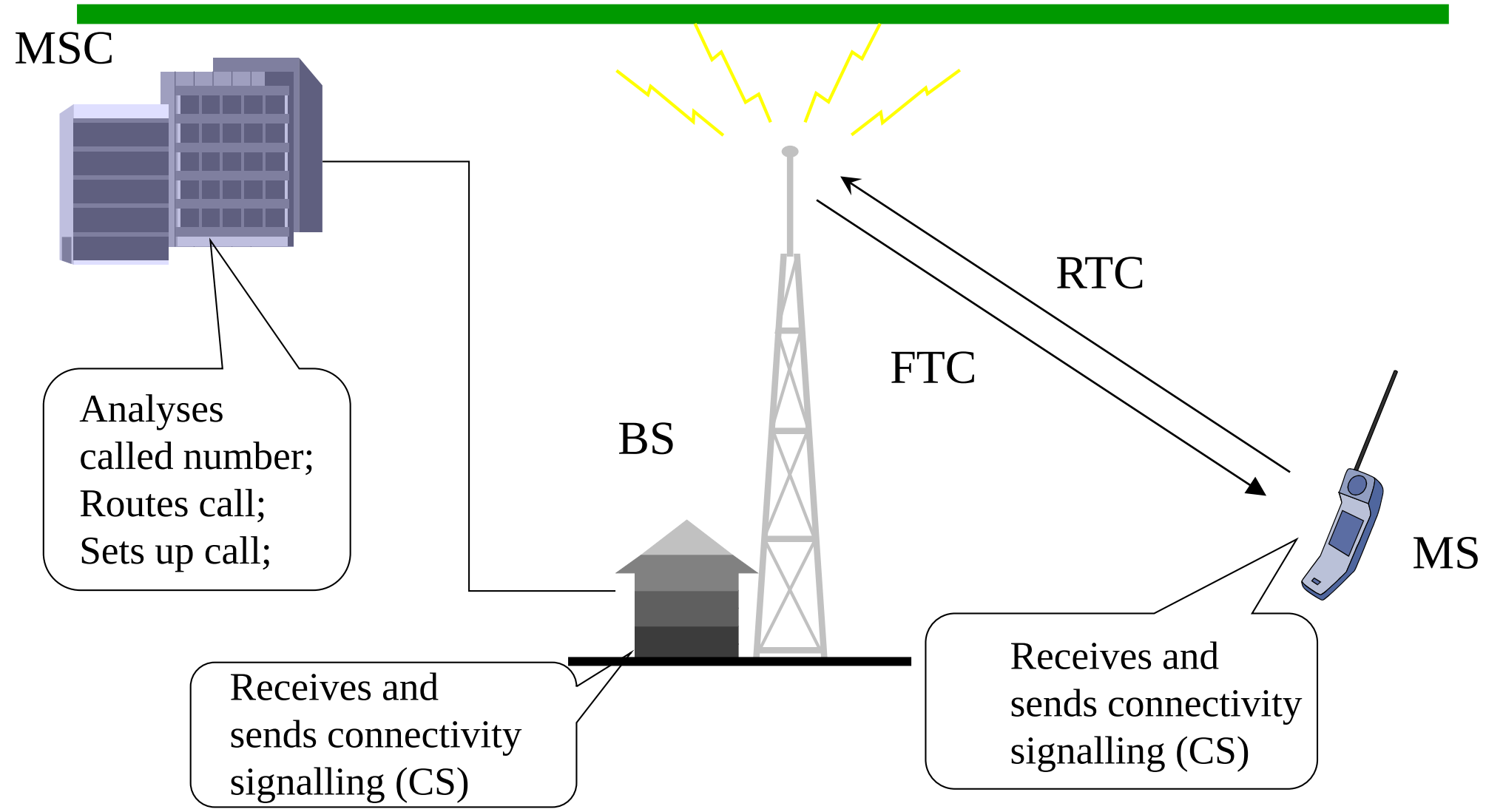
Basic Cellular Operation – Mobile Originated Call (step 4)



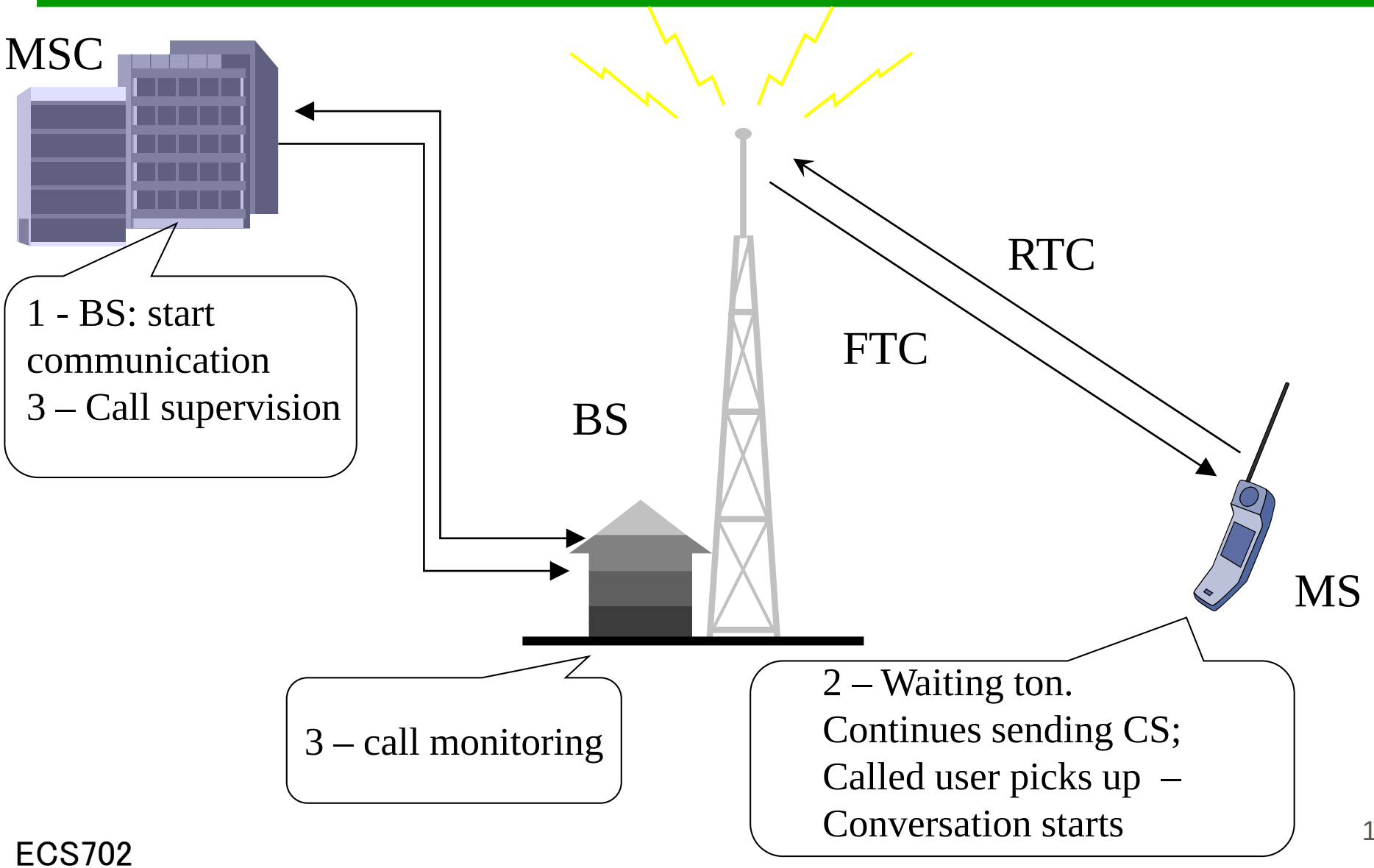
Basic Cellular Operation – Mobile Originated Call (step 5)



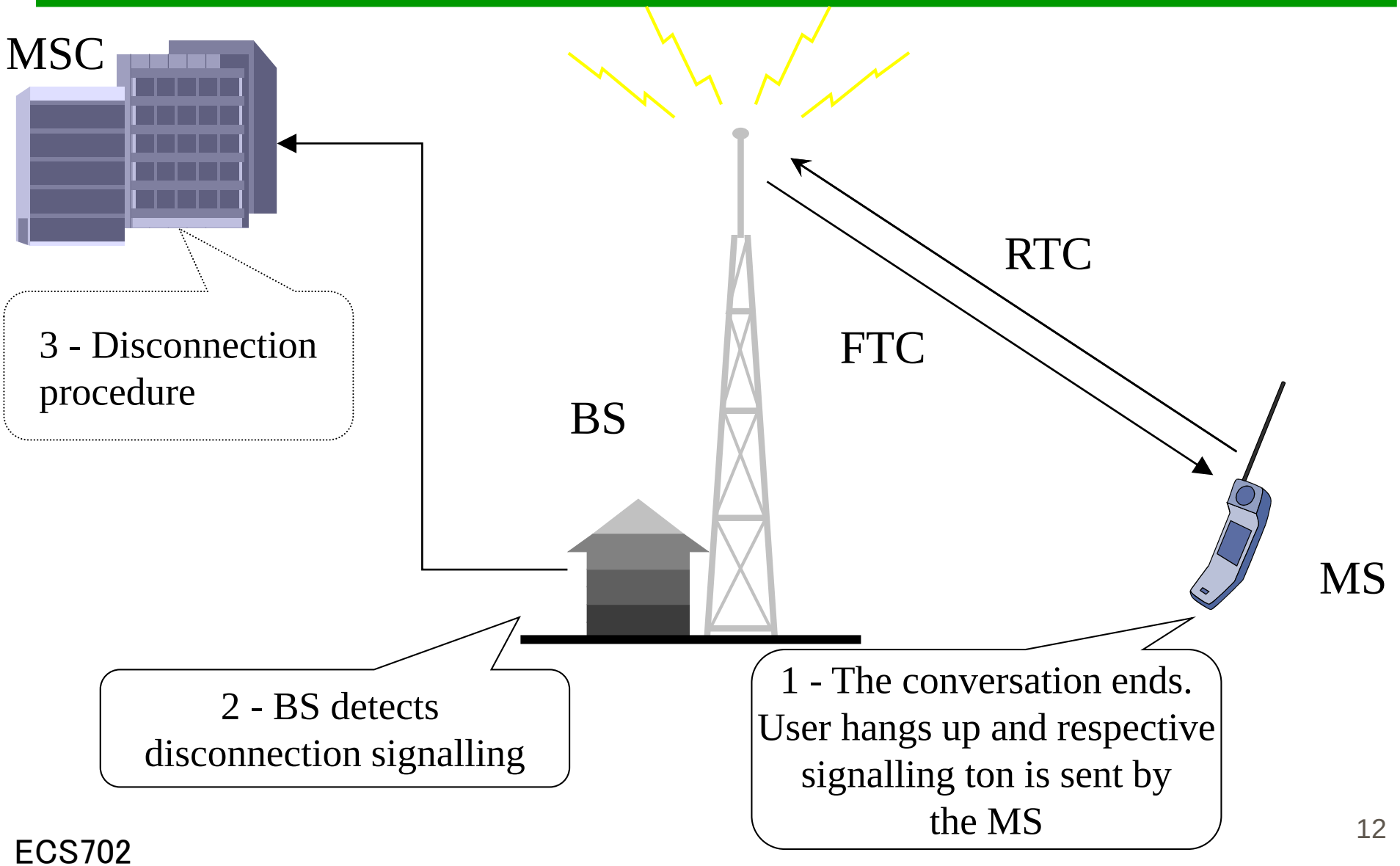
Basic Cellular Operation – Mobile Originated Call (step 6)



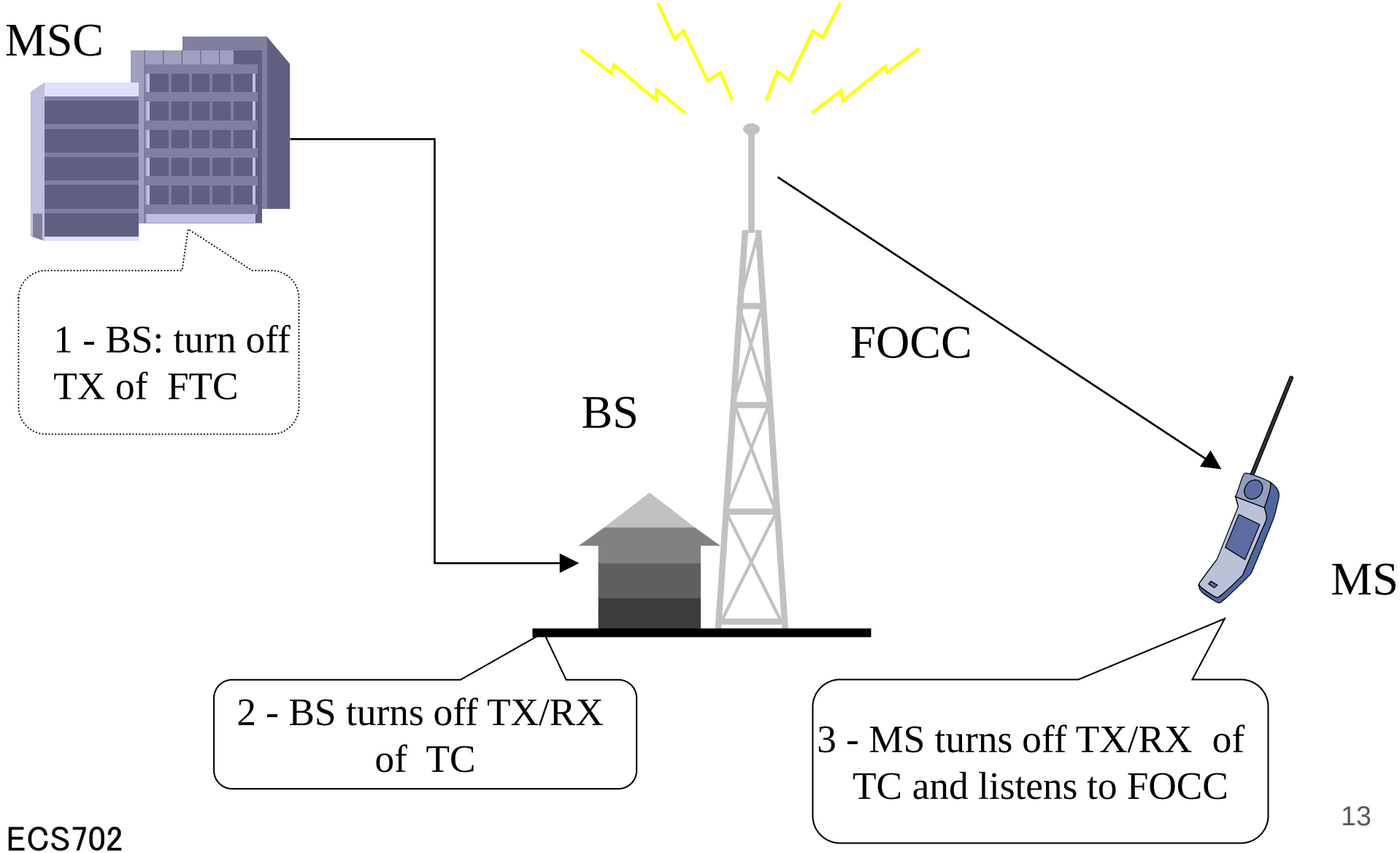
Basic Cellular Operation – Mobile Originated Call (step 7)



Basic Cellular Operation – Mobile Originated Call (step 8)



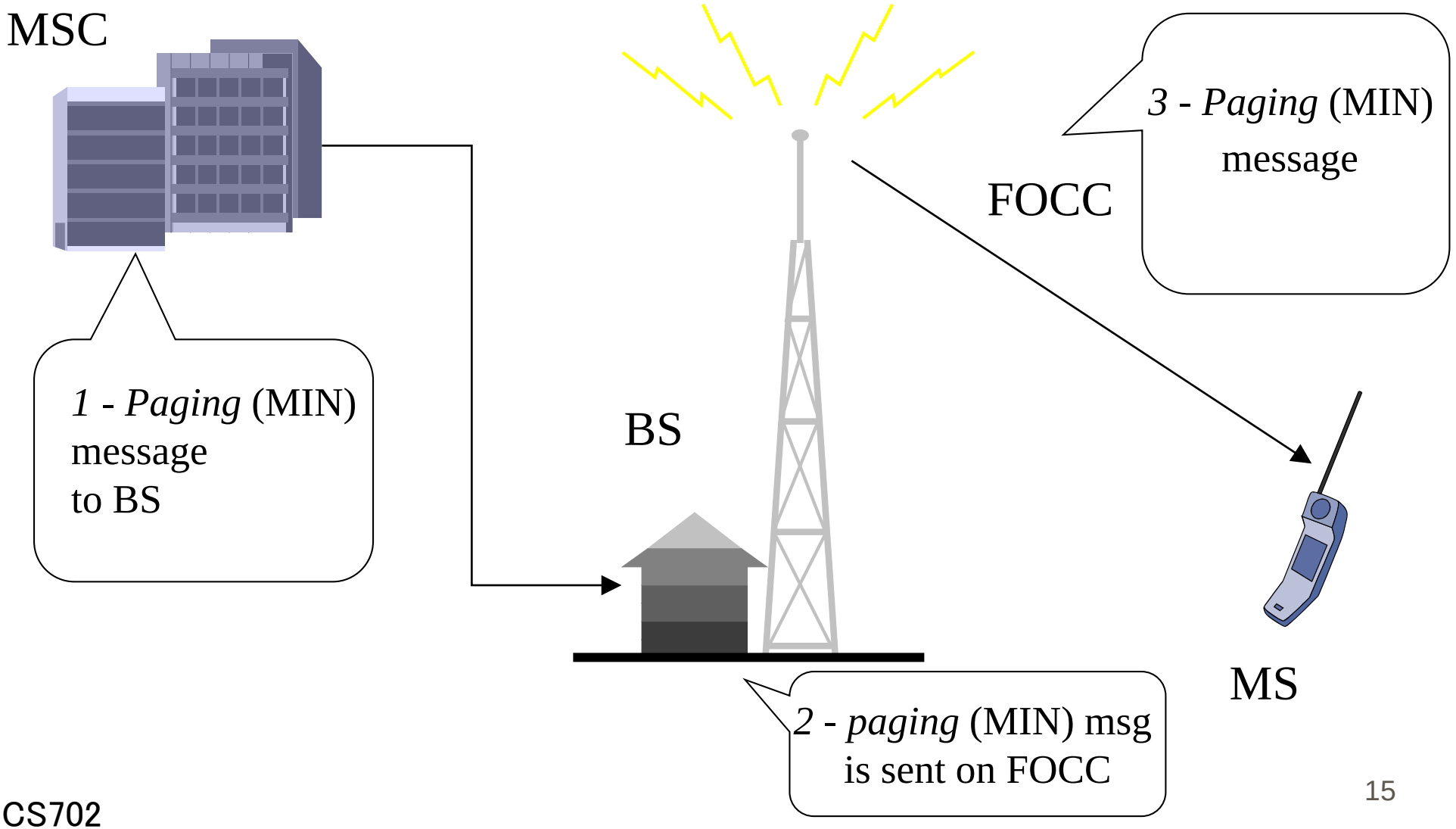
Basic Cellular Operation – Mobile Originated Call (step 9)



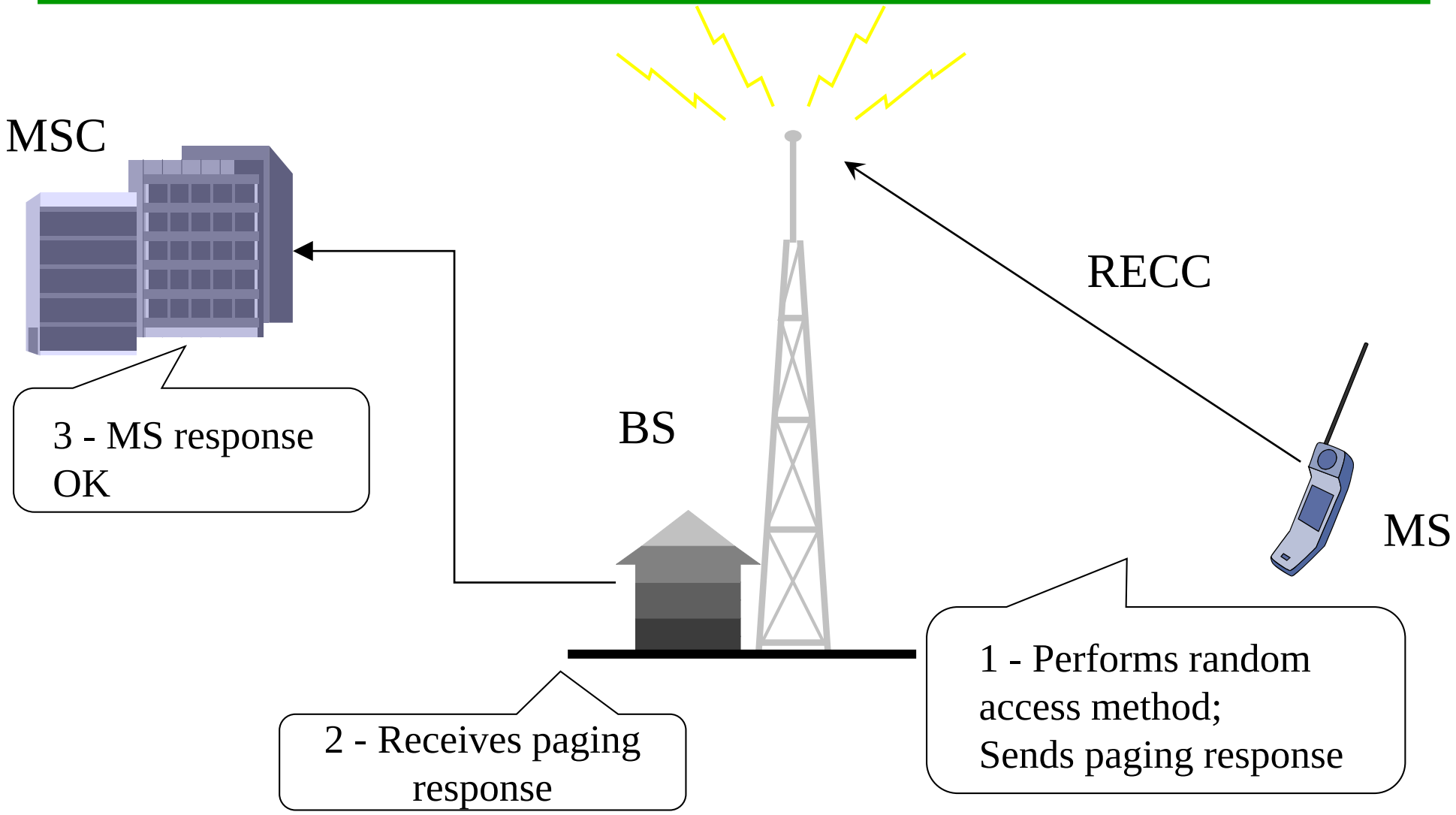
Mobile Originated Call - Summary

Pass to PSTN	←	Origination message (MIN, ESN, called party)
Control message	→	Tune to voice channel
Send supervisory signal to confirm forward channel	→	
Answers and starts conversation	←	Send supervisory signal to confirm reverse channel

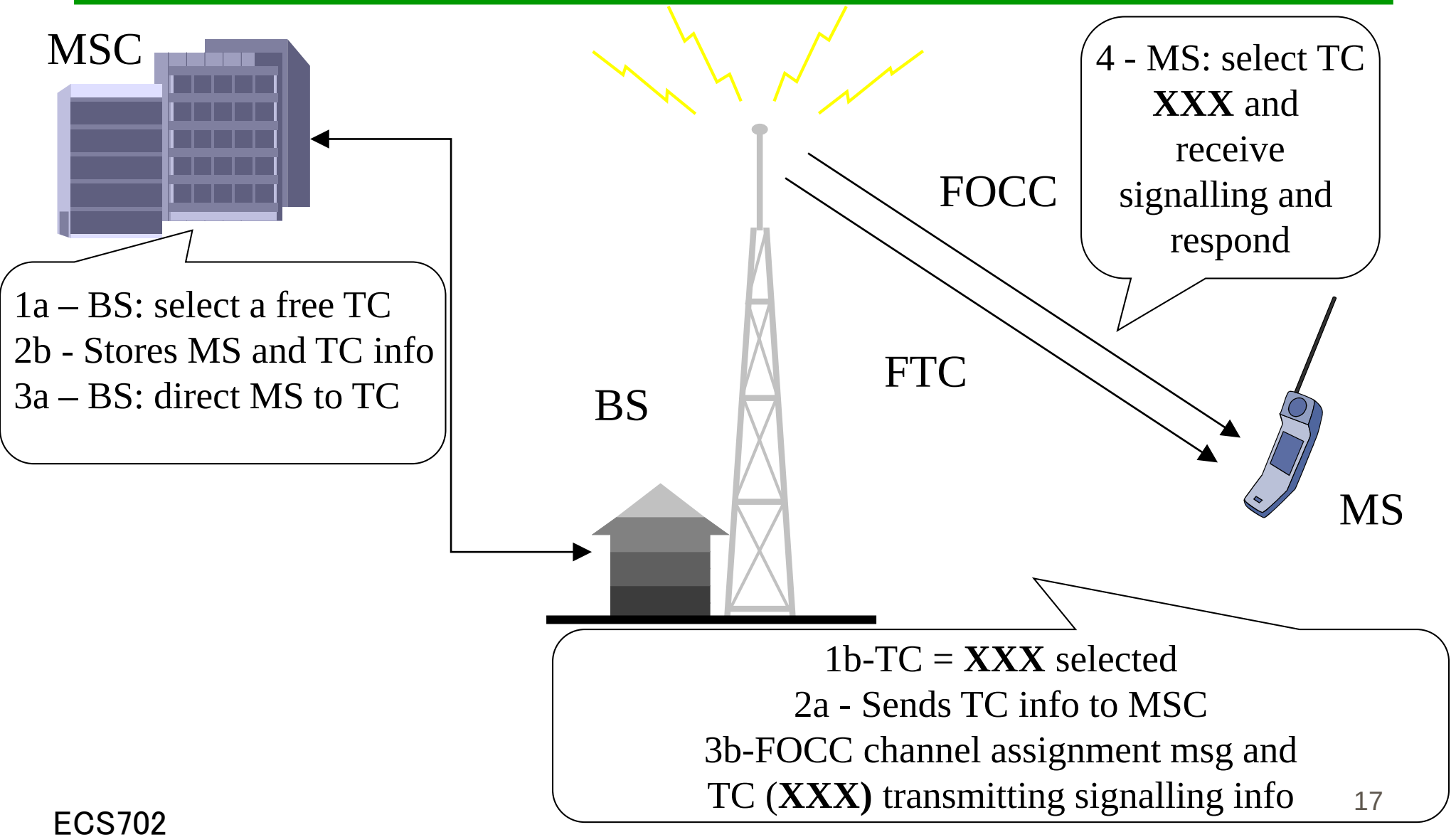
Basic Cellular Operation – Mobile Call Reception (step 1)



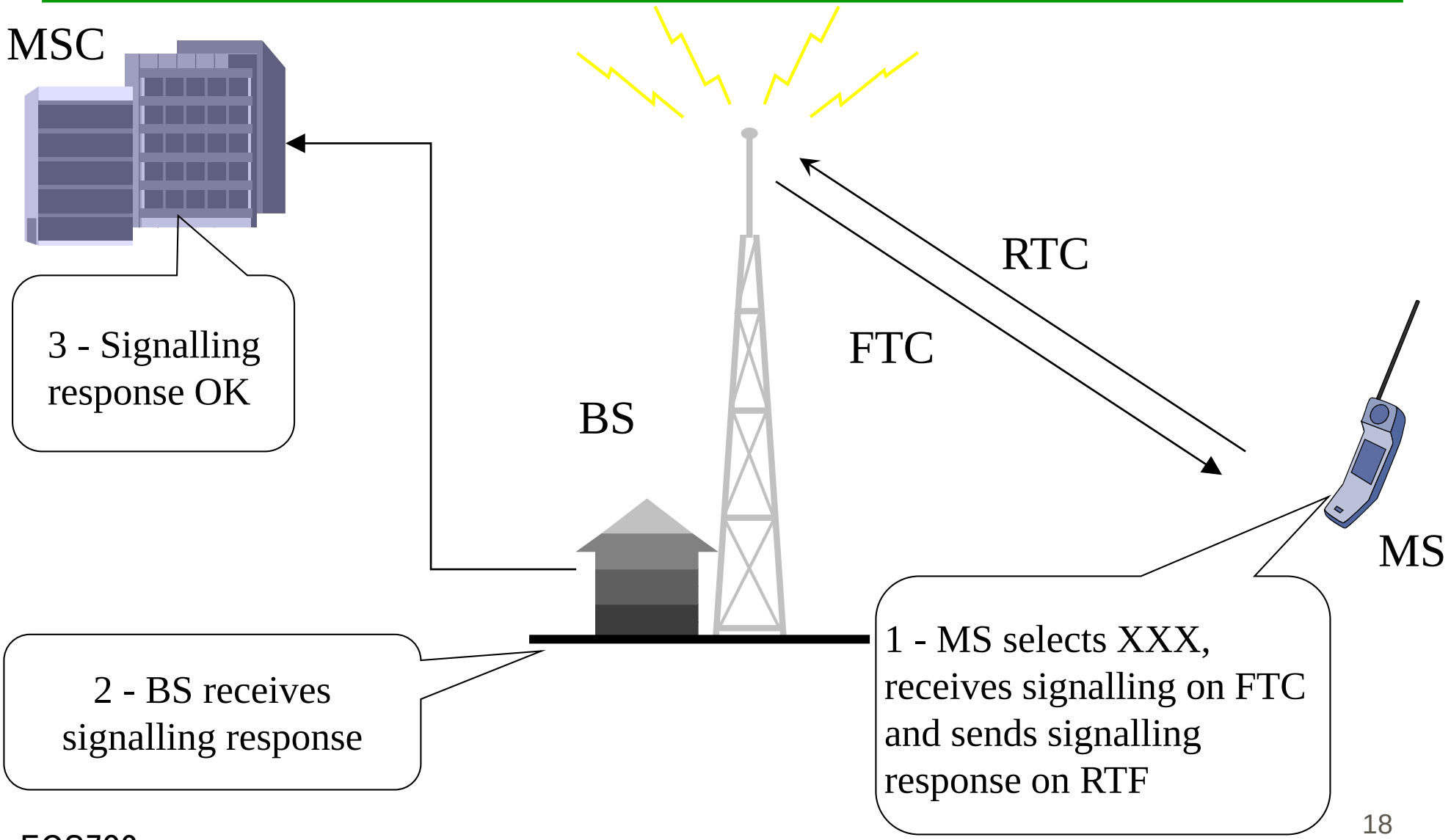
Basic Cellular Operation – Mobile Call Reception (step 2)



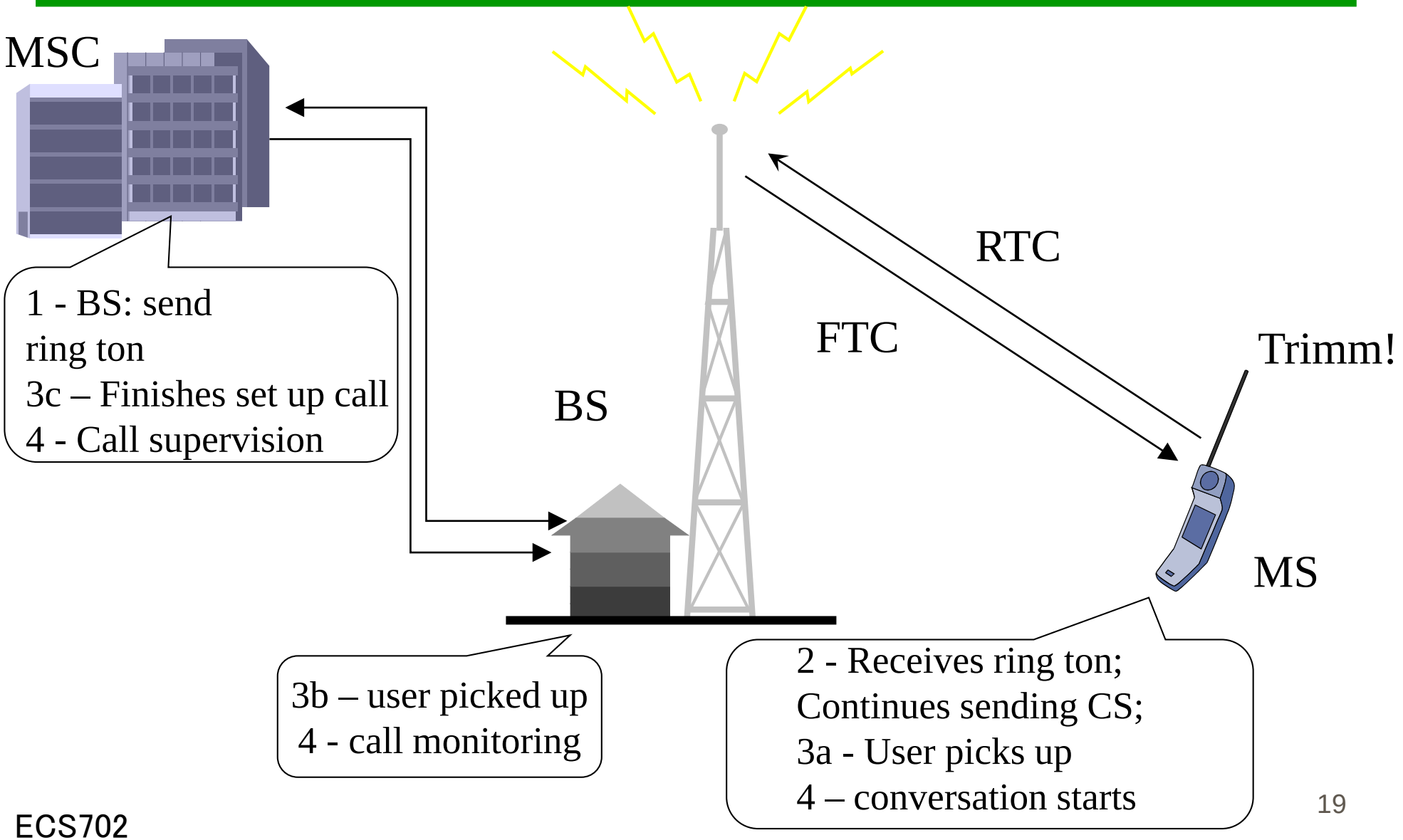
Basic Cellular Operation – Mobile Call Reception (step 3)



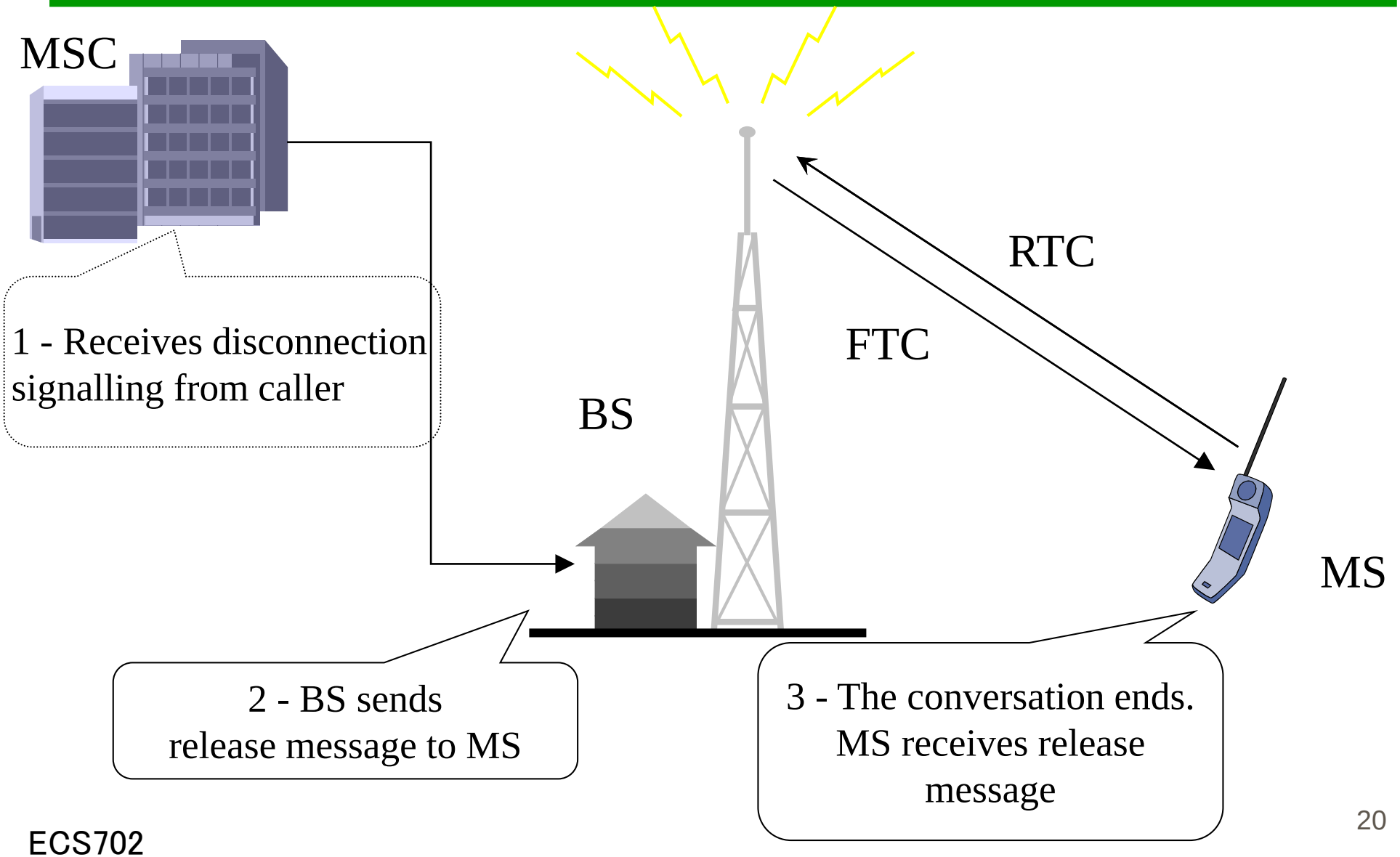
Basic Cellular Operation – Mobile Call Reception (step 4)



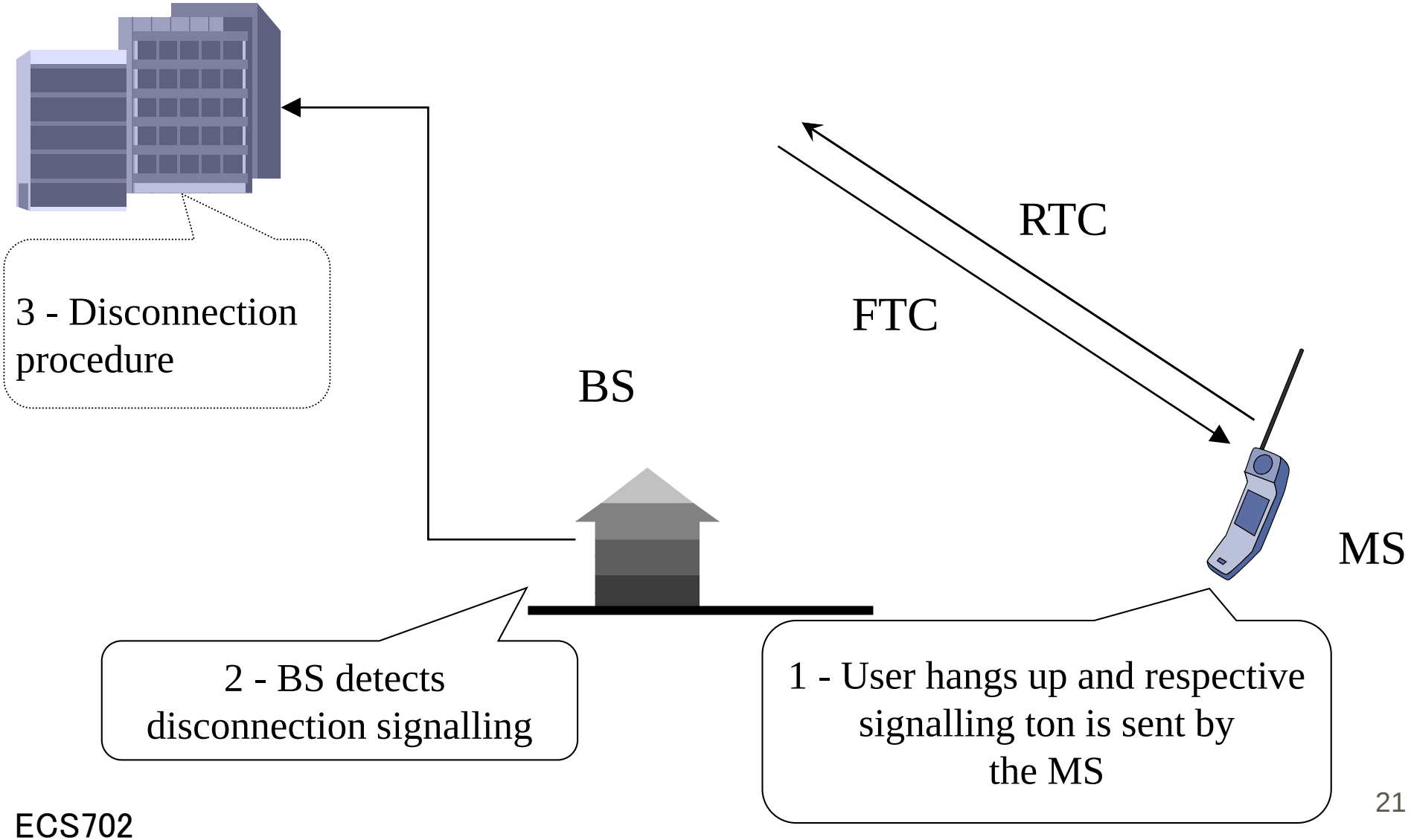
Basic Cellular Operation – Mobile Call Reception (step 5)



Basic Cellular Operation – Mobile Call Reception (step 6)



Basic Cellular Operation – Mobile Call Reception (step 7)



Mobile Call Reception - Summary

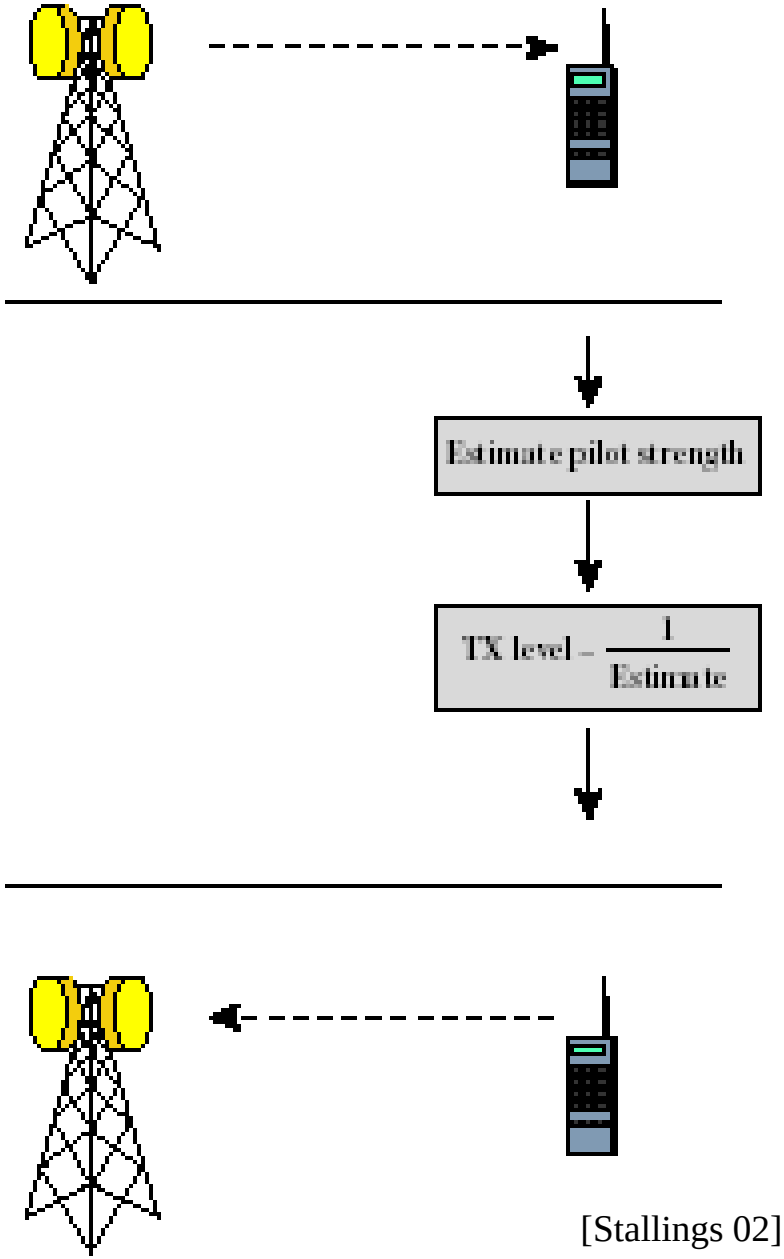
Mobile ID from PSTN; page control message	→	Receives page
	←	Page response message (MIN, ESN)
Control message; tune to voice channel	→	Tune to voice channel
Send supervisory signal to confirm forward channel	↔	Send supervisory signal to confirm reverse channel

Power Control

- The transmit power must be dynamically changed in order to maintain good communication quality in the presence of, for example:
  - Fading
  - Different mobile speeds
  - Mobile distance from the BS, etc.
- There are two generic mechanisms by which the MS and BS can adjust their transmit power
  - Open loop power control
  - Closed loop power control

Open-loop power control

- Used in IS-95 (CDMA)
- The power control is made on the reverse link
  - No feedback from BS
- The MS measures the quality of a reference channel from the base station
  - Based on what?
  - How?
- Disadvantages:
  - The decision is based on the quality of the forward channel
    - the reverse and forward channel are not usually correlated
  - It may exist a significant delay
- Not as accurate as closed-loop, but it can react quicker to fluctuations in signal strength

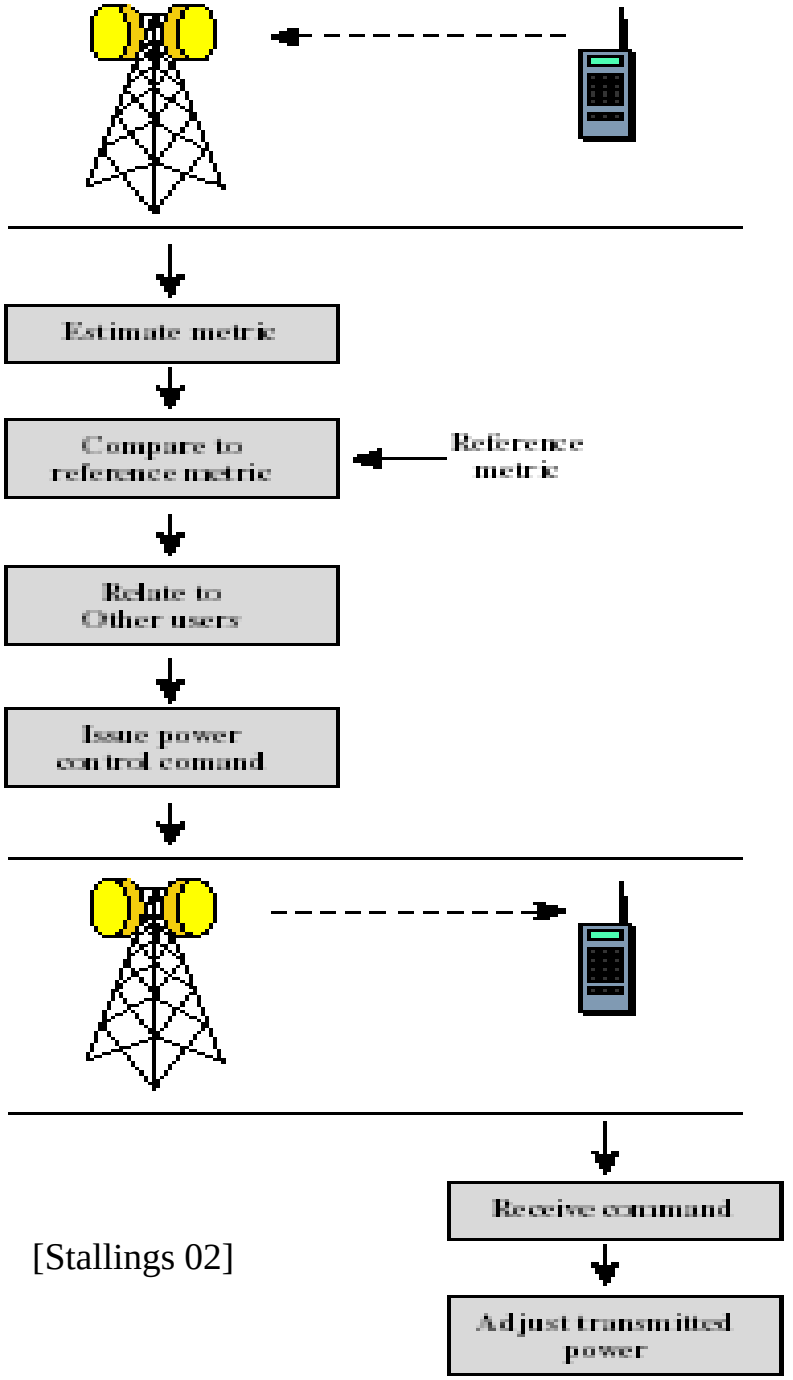


[Stallings 02]

(a) Open-loop power control

Closed-loop power control

- Used in GSM
- Eliminates the disadvantages of the open loop power control by implementing a feedback mechanism between the BS and the MS
- The BS measures the quality of the signal received from the MS and adjusts (based on metric of performance - RSS, SIR or BER) the signal strength that the reverse channel should apply
- Base station makes the power adjustment decision and communicates to mobile on control channel



[Stallings 02]

Power Saving

- Additional mechanisms for saving battery power of the MS
- battery power
  - Mostly consumed during transmission
  - A significant amount is during reception of signal
  - An order of magnitude less power in a standby (idle) mode
- MS is designed to spend most of its time in standby or sleep mode
- For voice terminals, a *voice activity detector* is used
  - reduce or completely stop the transmit power when there is no speech activity
- ***Voice Activity Detection (VAD)***
- MS does not transmit any signal or repeat data in lower signal level
- Problems:
  - In high noise situations, the MS must be able to distinguish between useful signals in high noise or simply noise
  - If VAD is not implemented correctly, there may be annoying effects for the user
- Tests also have shown:
  - In absolute no transmission, the silent gaps are extremely annoying
  - Solution: insert a very low power *comfort noise* signal during silent gaps

References

- [Far96] Saleh Faruque. Cellular Mobile Systems Engineering. *Mobile Communication Series*. Artech House Publishers. ISBN 0-89006-518-7.1996.

- [Lee 95] William C. Y. Lee. Mobile Cellular Telecommunications: Analog and Digital Systems. Second Edition. McGraw-Hill, Inc. ISBN 0-07-038089-9. 1995.

- [PK 02] Kaveh Pahlavan and Prashant Krishnamurthy. Principles of Wireless Networks. *Prentice Hall*. ISBN 0-13-093003-2, 2002.

- [Mac 79] V. H. Mac Donald. Advanced Mobile Phone Service: The Cellular Concept. *The Bell System Technical Journal*, volume 58, number 1, pages 15-41, January 1979.

- [Stallings 02] William Stallings. Wireless Communications and Networks. *Prentice Hall*. ISBN 0-13-040864-6, 2002.

Class Quiz

- How is the traffic intensity defined?
- How is the quality of service related to traffic intensity and channels?
- What are the open loop and closed loop power control, respectively?

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