UHF band(860-960MHz) RFID development in Japan

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Agenda

- Features of UHF band RFID system
  - Long range communication
  - Multiple tag reading
  - What deteriorates the reading accuracy ?
- Radio Regulations around UHF band RFID system
  - Radio regulations?
  - Japan status

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Executive summary

- **UHF band RFID features 5-10m reading distance. Primary target is supply chain management.**
- **Reading accuracy depends on the radio propagation environment as well as tag and reader performance.**
- **952-954MHz band will be opened to RFID system in Japan from early FY.2005.**

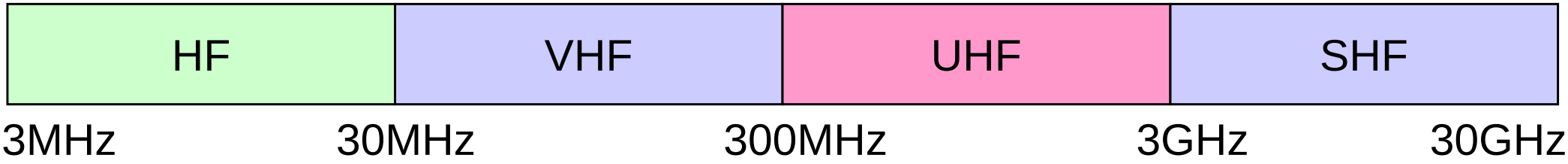
UHF band?

TV ch.1 = 90-96MHz
TV ch.12 = 216-222MHz

UHF TV
470-770MHz

Cellular Phone etc.
810-960MHz

Satellite Broadcasting
12GHz



860-960MHz RFID

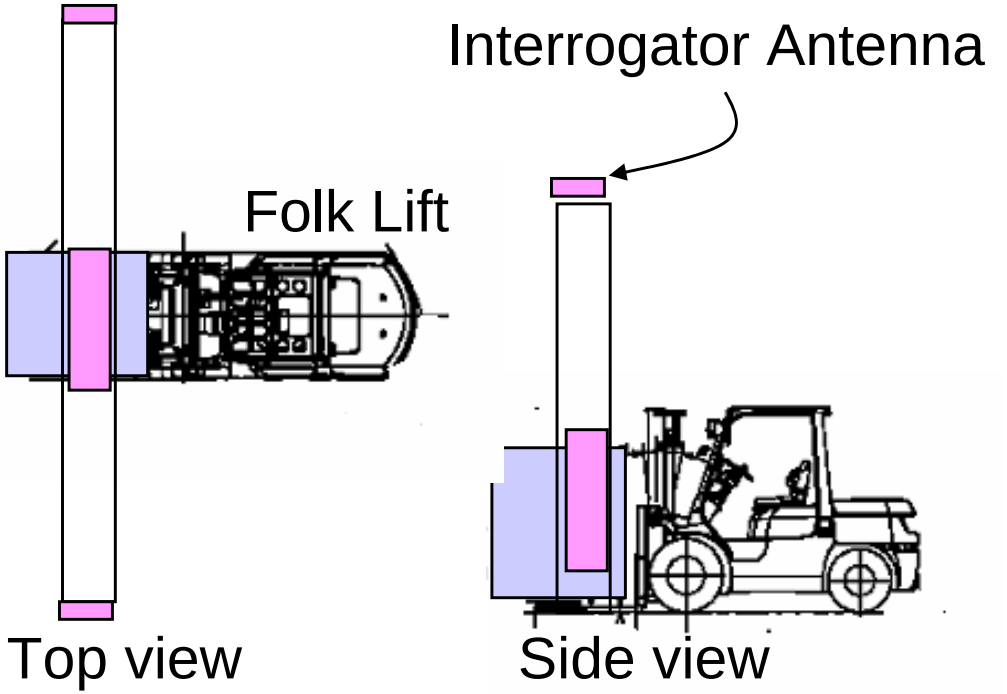
13.56MHz RFID

2.45GHz RFID

Frequently referred to as UHF RFID

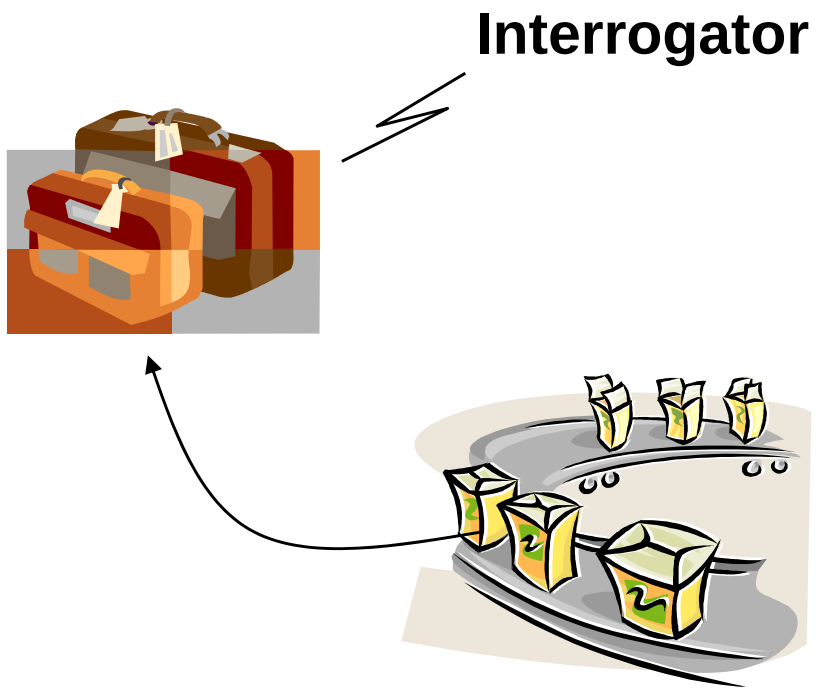
Typical Usages of UHF RFID

High power type



Long range, multiple tags reading

Low power type



Short range, individual tag reading

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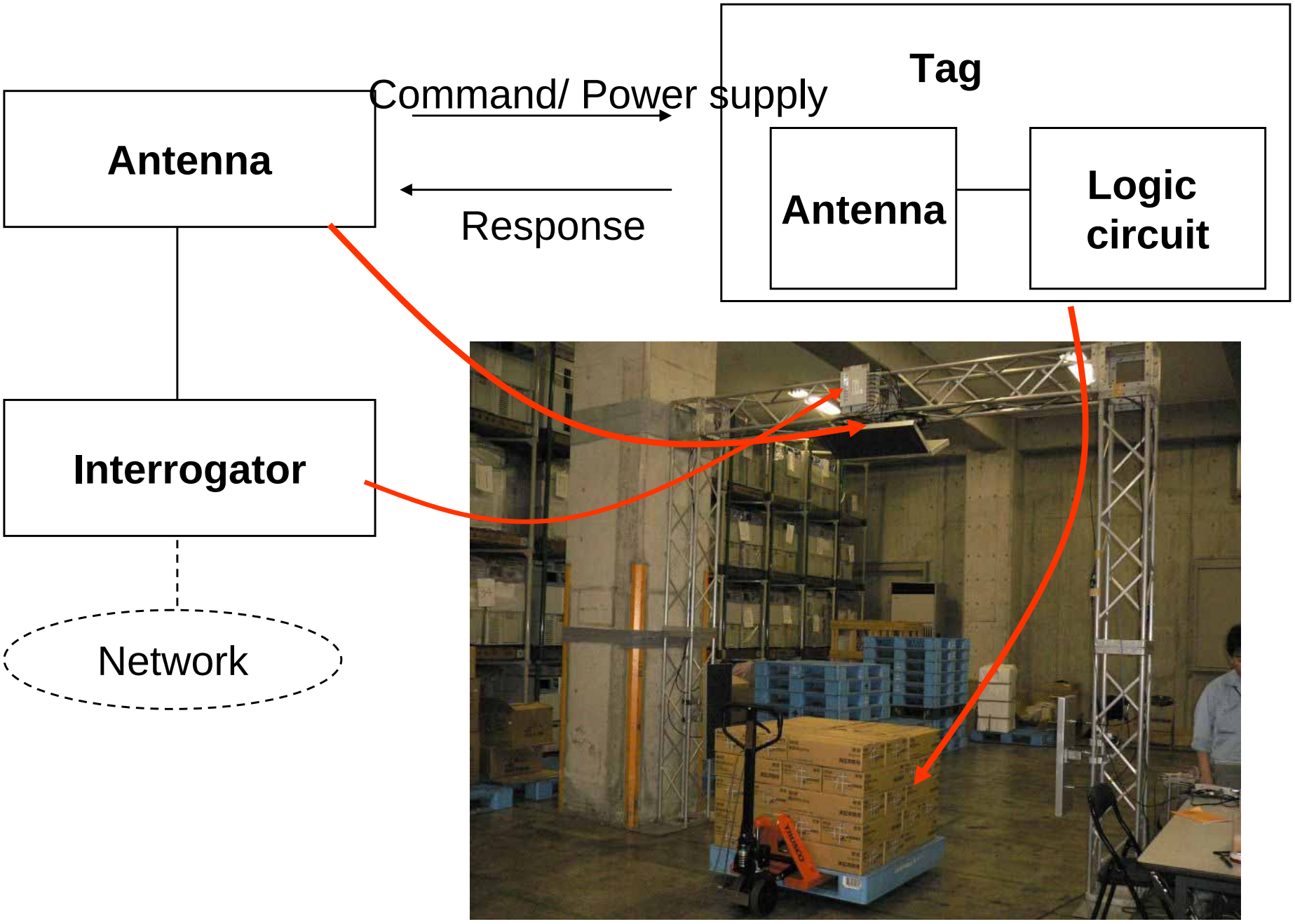
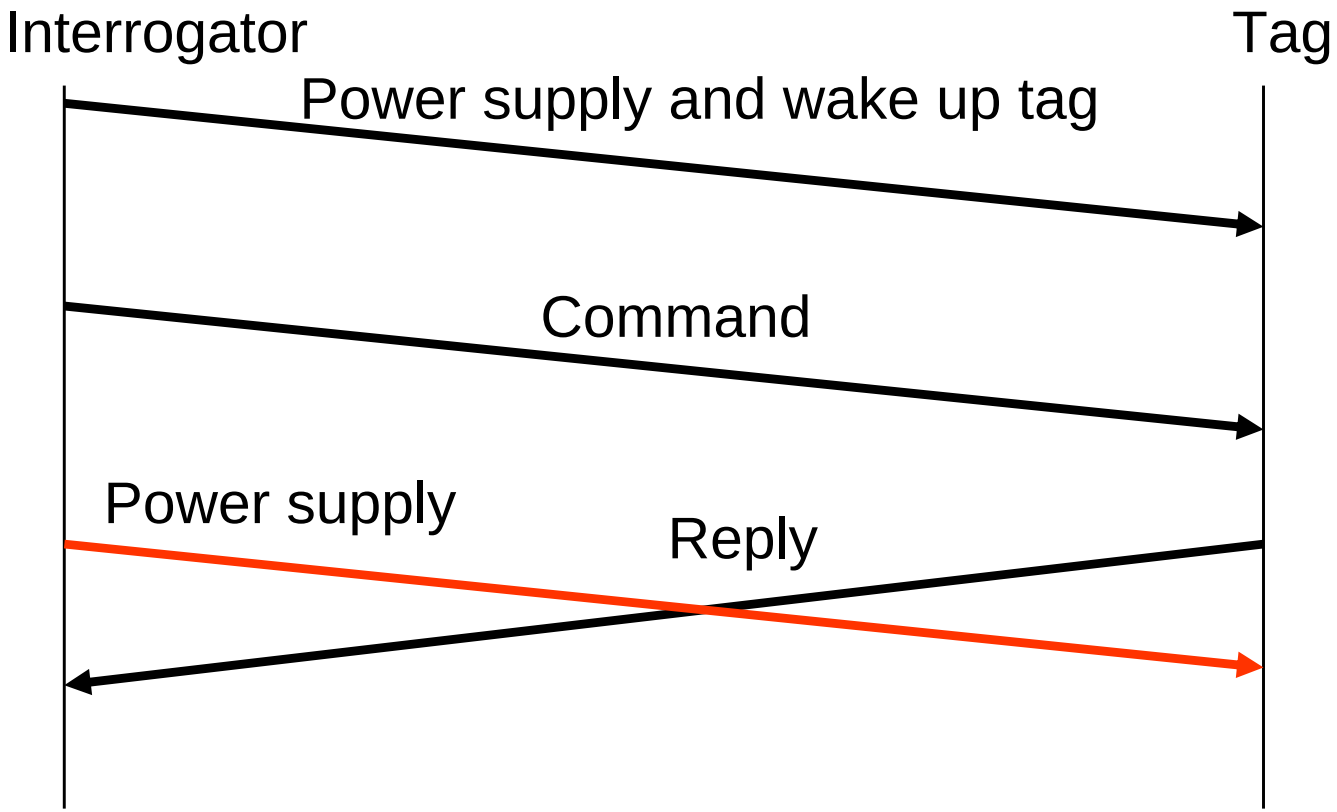
Class of RFID system

- **Active RFID:**
  - **carries battery for radio wave transmission**
- **Passive RFID**
  - **Passive backscatter: Power is supplied by interrogator in the form of radio wave.**
    - **Read only**
    - **Read/Write**
  - **may carry battery to power the logic circuit in tag (semi-passive).**

Basics of UHF passive RFID

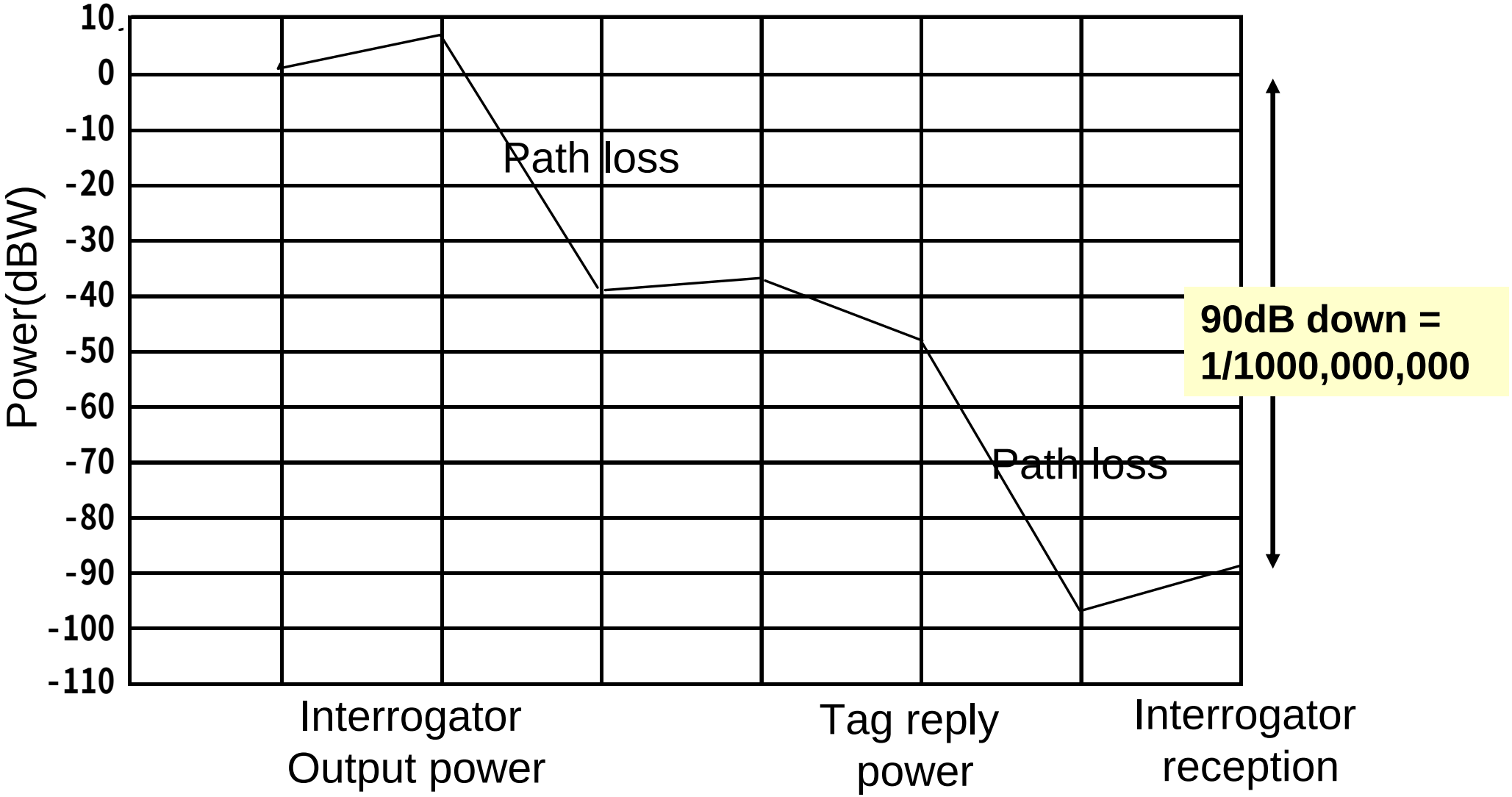


Interrogator – Tag communication in a nutshell



Power shall be supplied to tags by interrogator while tags reply.

Power level chart



Fundamental dilemma of passive RFID

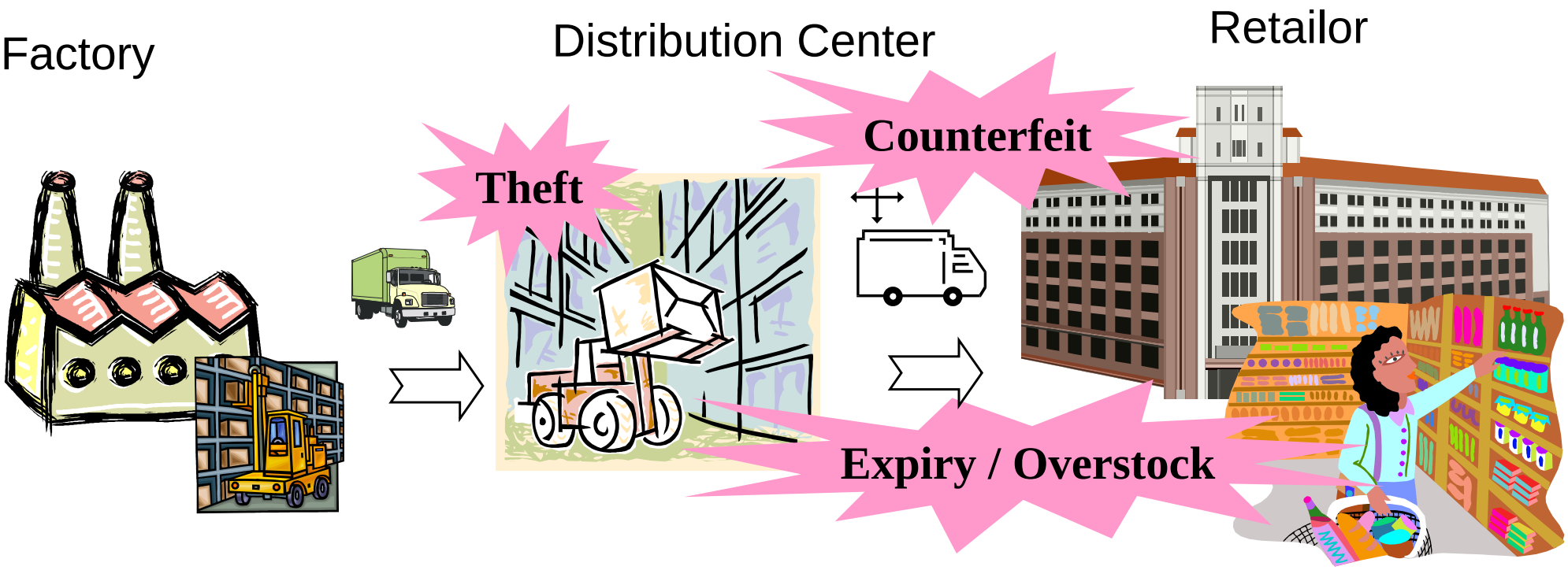
- Tag needs to efficiently absorb the radio wave energy from interrogator.
- Tag needs to reflect the radio wave, generating 1 and 0 states, for the reply.

Absorb ? Reflect?

Solutions

- Optimal design of tag impedance
- Separate antennas for power supply and communications

What is the purpose of UHF RFID?

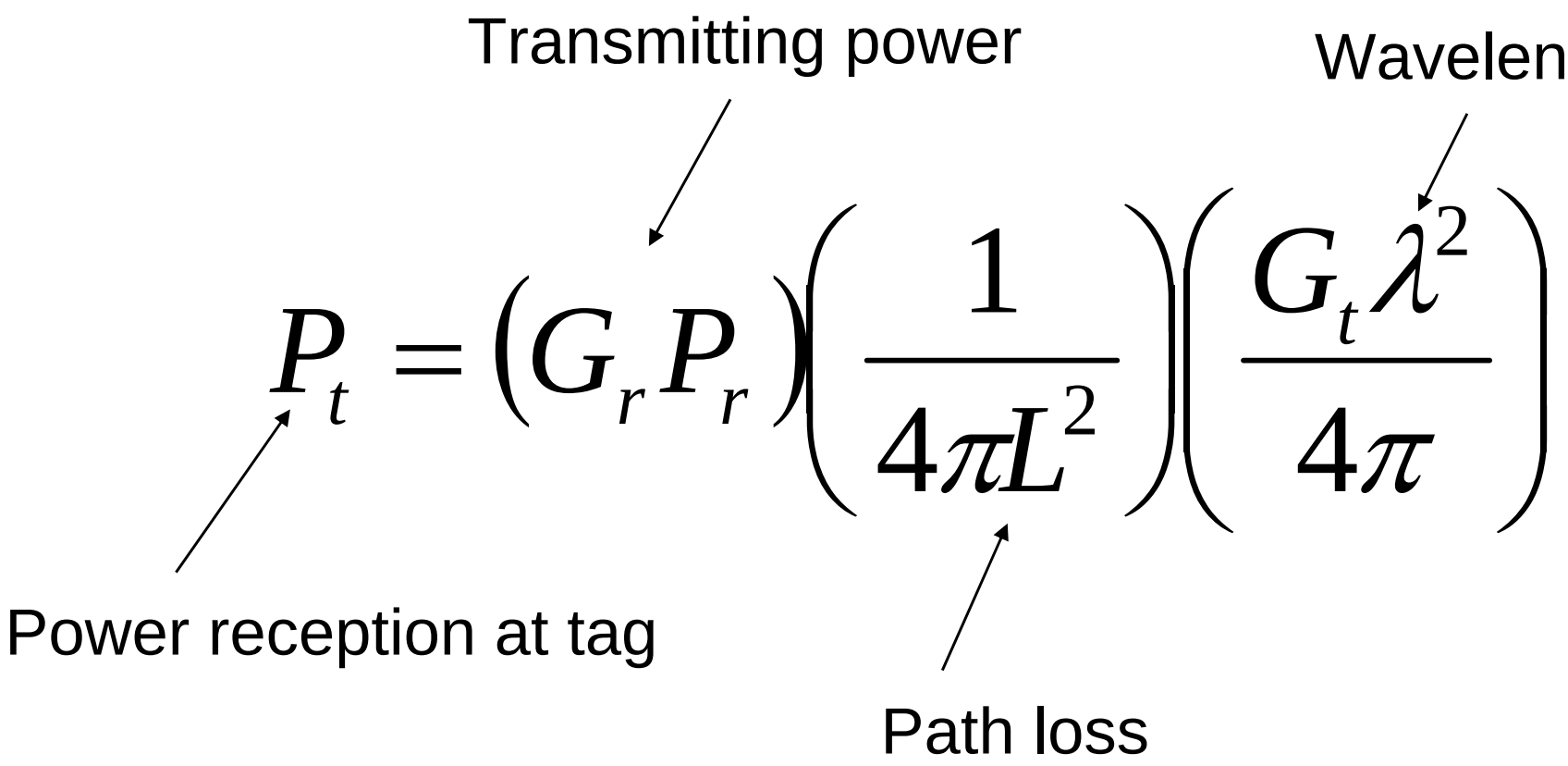


Accurate and real-time visibility of total supply chain by RFID

Why UHF?

- **Long range communications requirement**

Why UHF? (2)



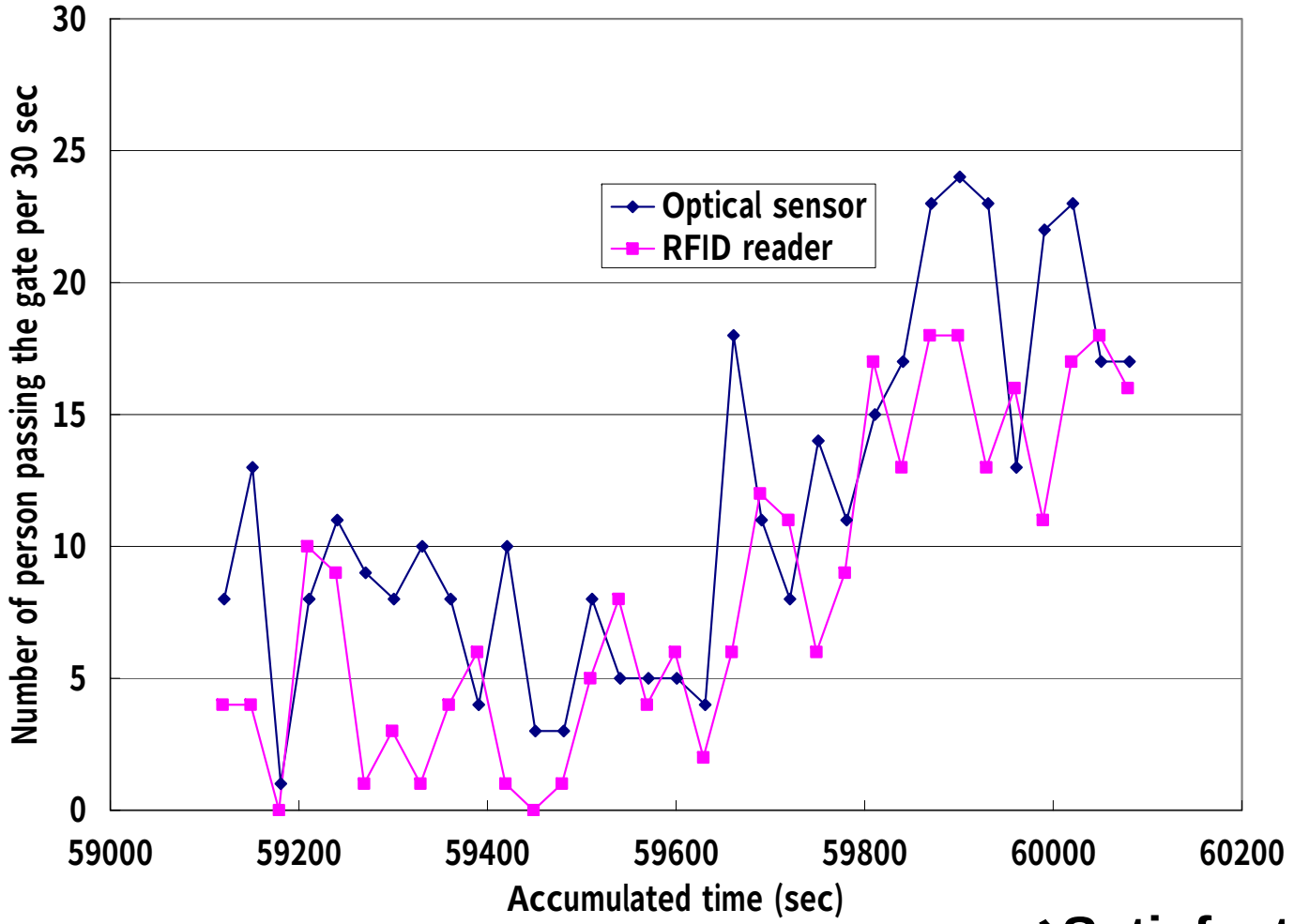
The lower the frequency, the larger the power reception.
The lower the frequency, the larger the tags becomes.
Good compromise = UHF band; Same story as cellular phone

Other application of UHF RFID system

Automatic participants tracking in Keio University Open Research Forum 2004.

Counting accuracy comparison

Comparison of number of passing participants
Counted by using optical gate sensor and RFID reader



→Satisfactory agreement

Note:
Not all the participants has UHF tag.
Optical sensor sometimes missed counting because of overwrapping of persons and/or bags

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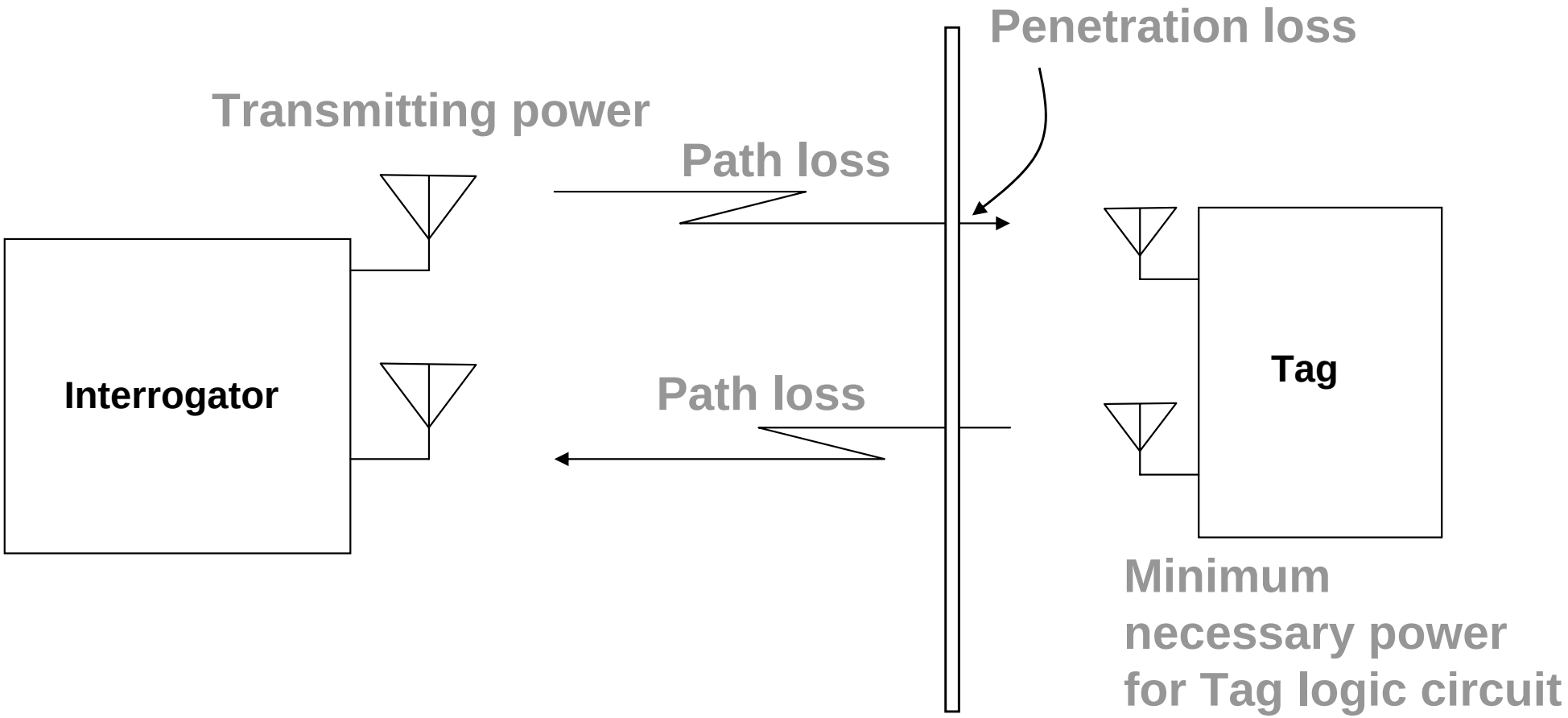
Detailed analysis on the reading accuracy

Test case	Person	Ouput level (EIRP)		
		27dBm (33dBm)	23.1dBm(29.1dBm)	18dBm(24dBm)
Case 1	Person 1	100%(20/20)	100%(20/20)	65%(13/20)
	Person 2	100%(20/20)	100%(20/20)	75%(15/20)
	Person 3	100%(20/20)	85%(17/20)	10%(2/20)
Case 2	Person 1		100%(20/20)	
	Person 2		80%(16/20)	
	Person 3		85%(17/20)	

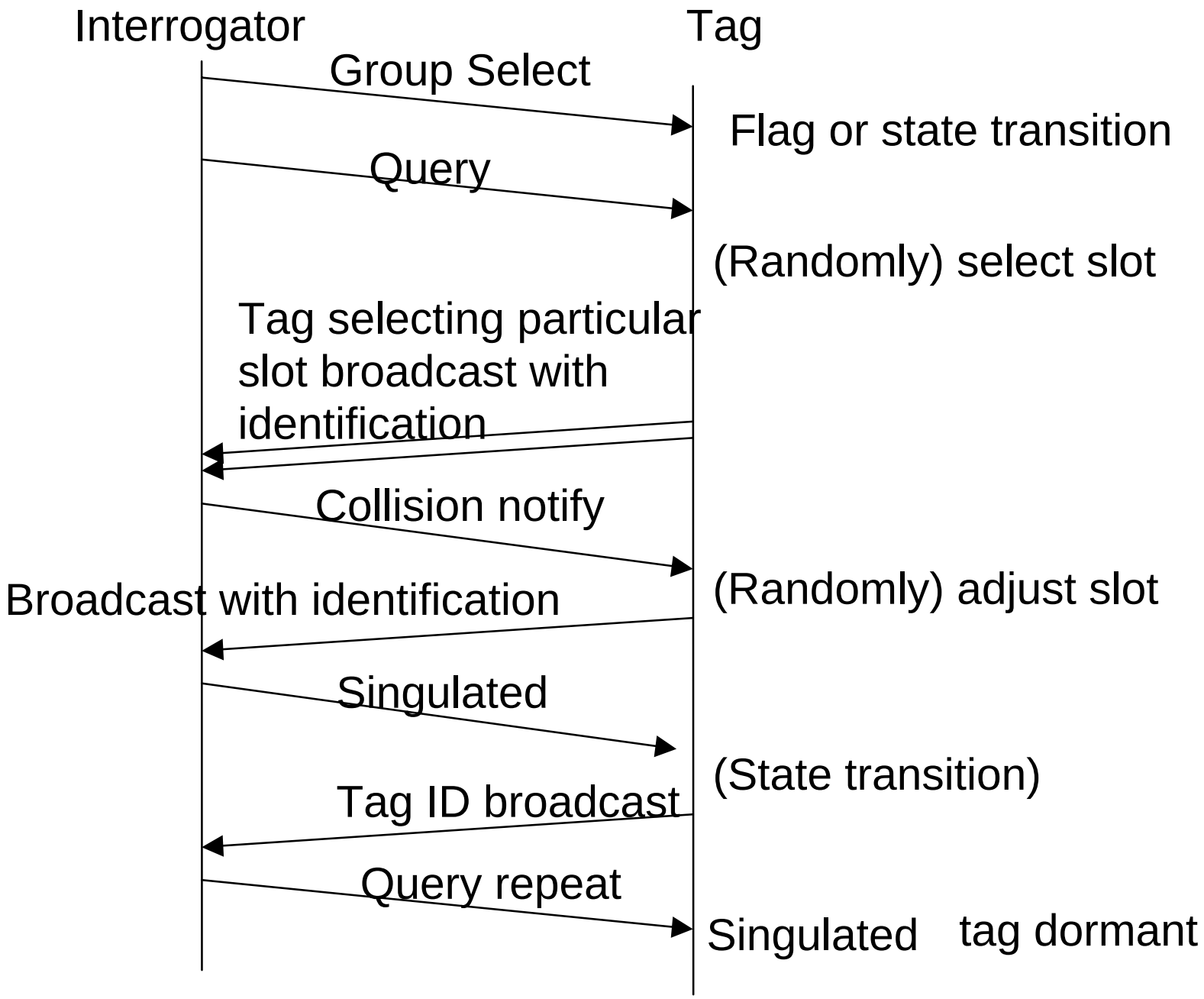
100% reading accuracy for 2W transmission power

Factors affecting the reading accuracy

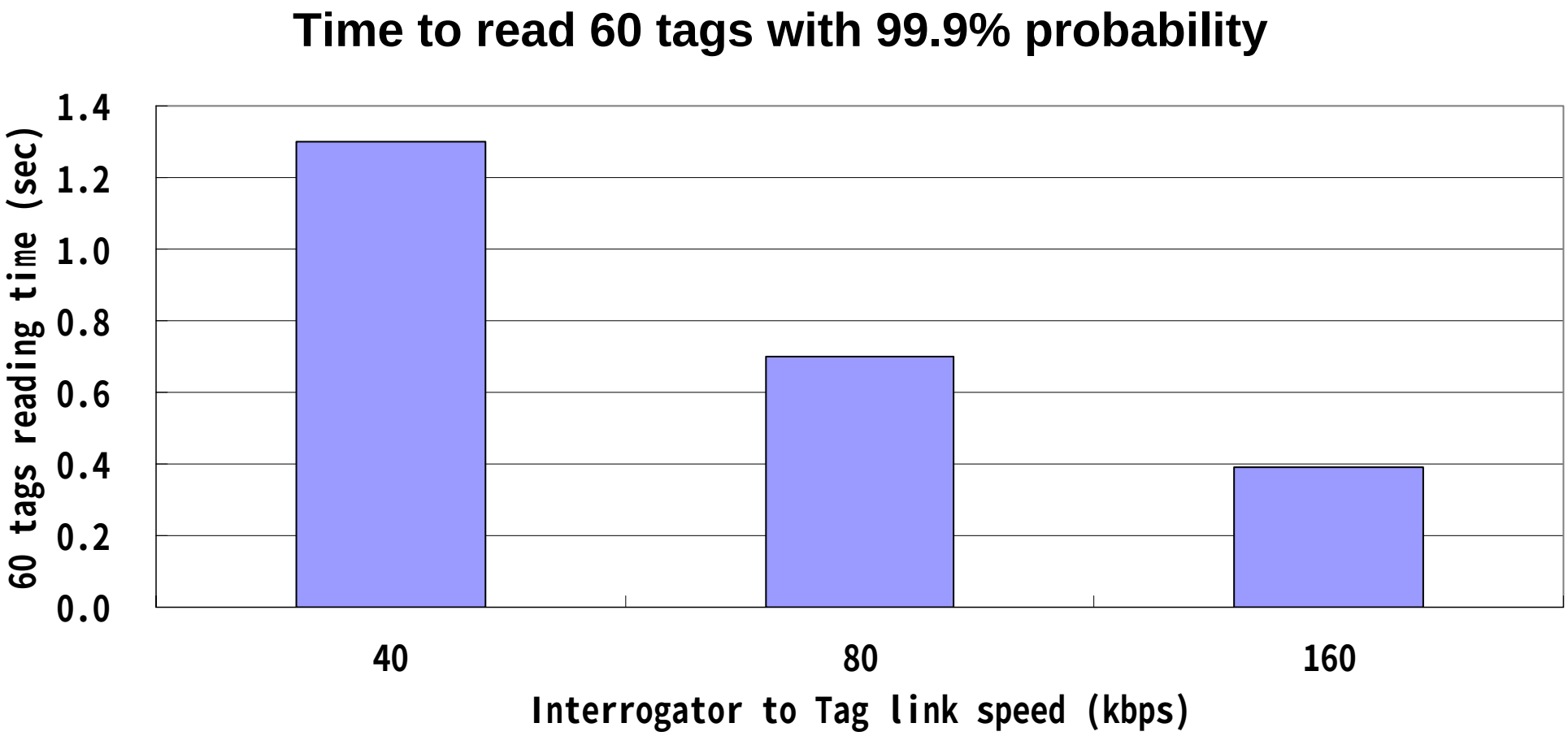


Exposure time to the sufficient power RF wave in case of a reading of population of tags

Multiple tag reading sequence



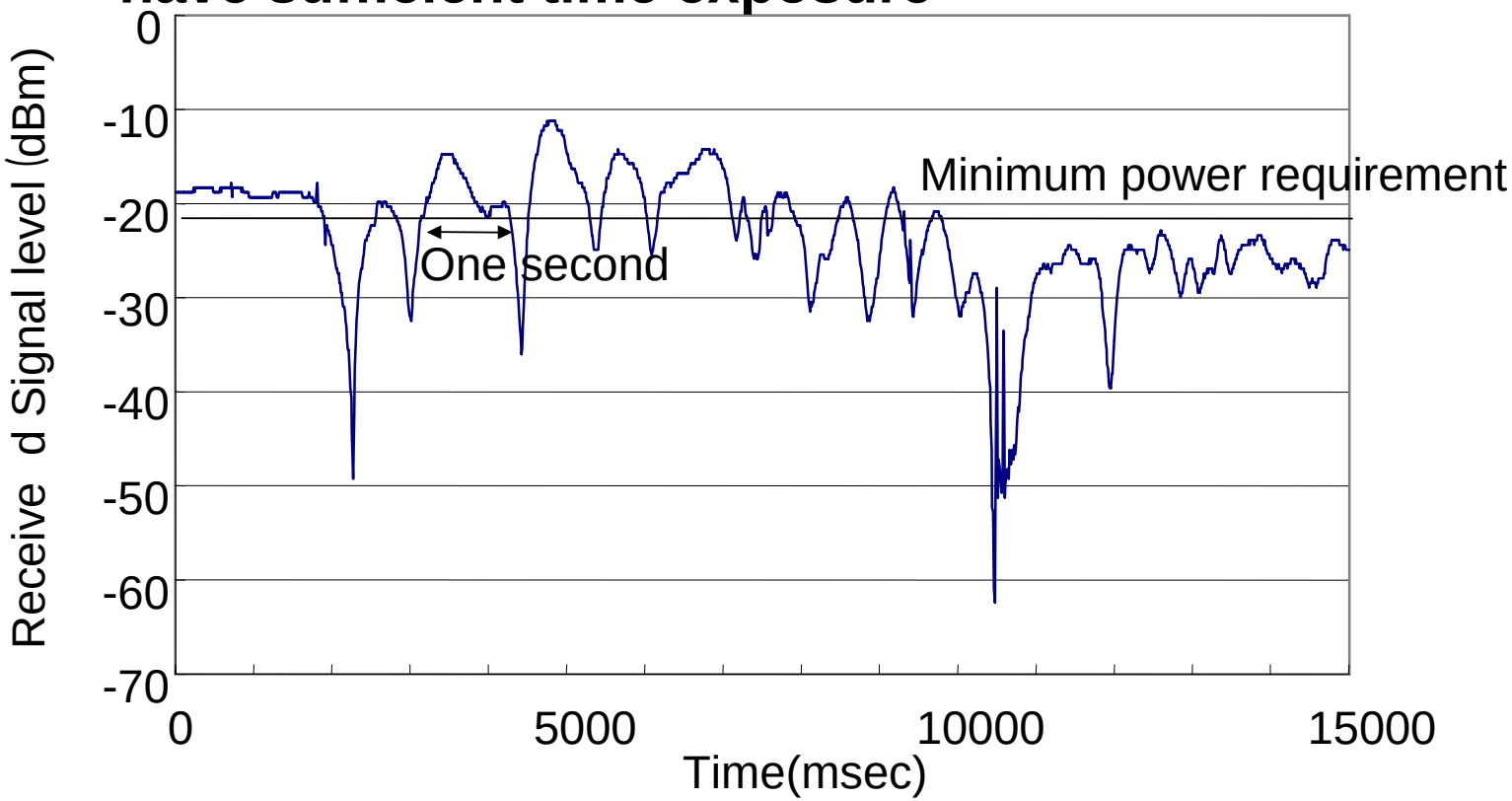
A prediction of 60 tags reading time

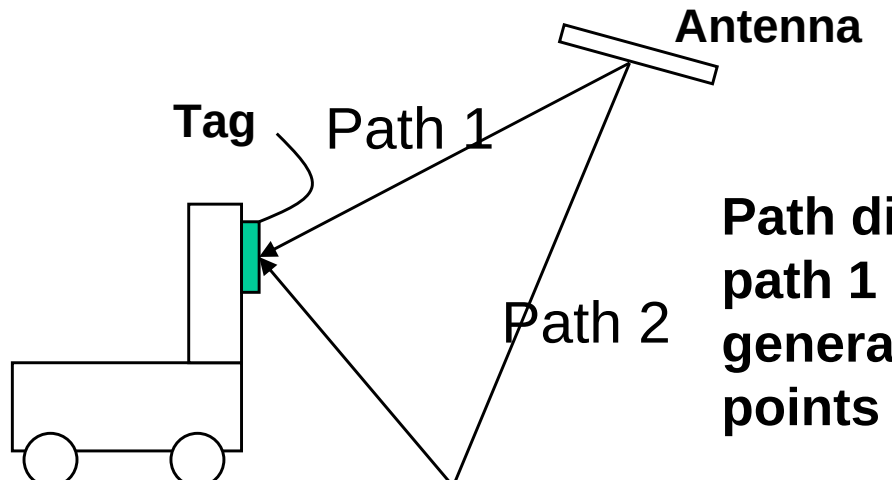


Certain amount of continuous exposure to sufficient power of RF wave is necessary for multiple tag reading

Practical power level fluctuation

In practical implementation, it is not always easy to have sufficient time exposure





Path difference between path 1 and path generates the blind points

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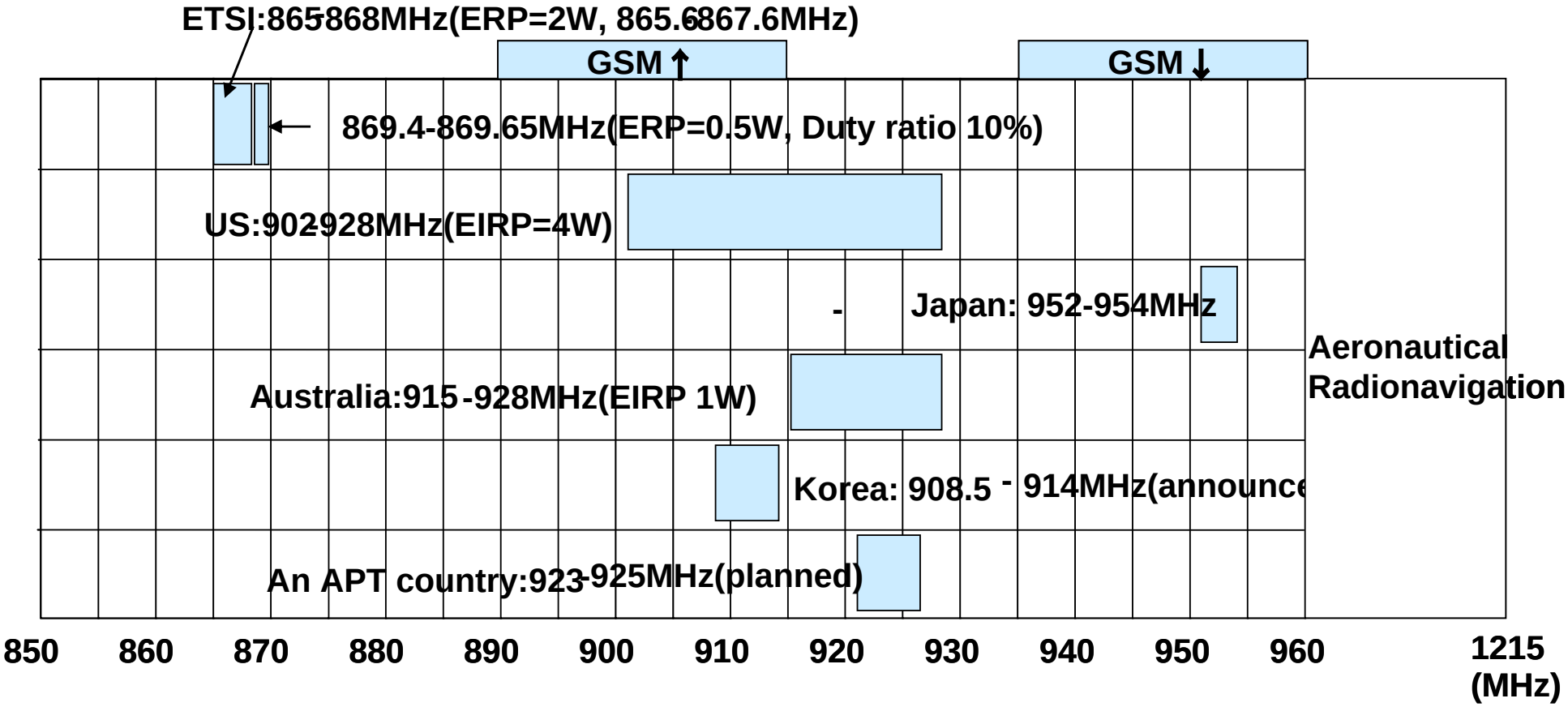
Frequency allocation status for UHF RFID

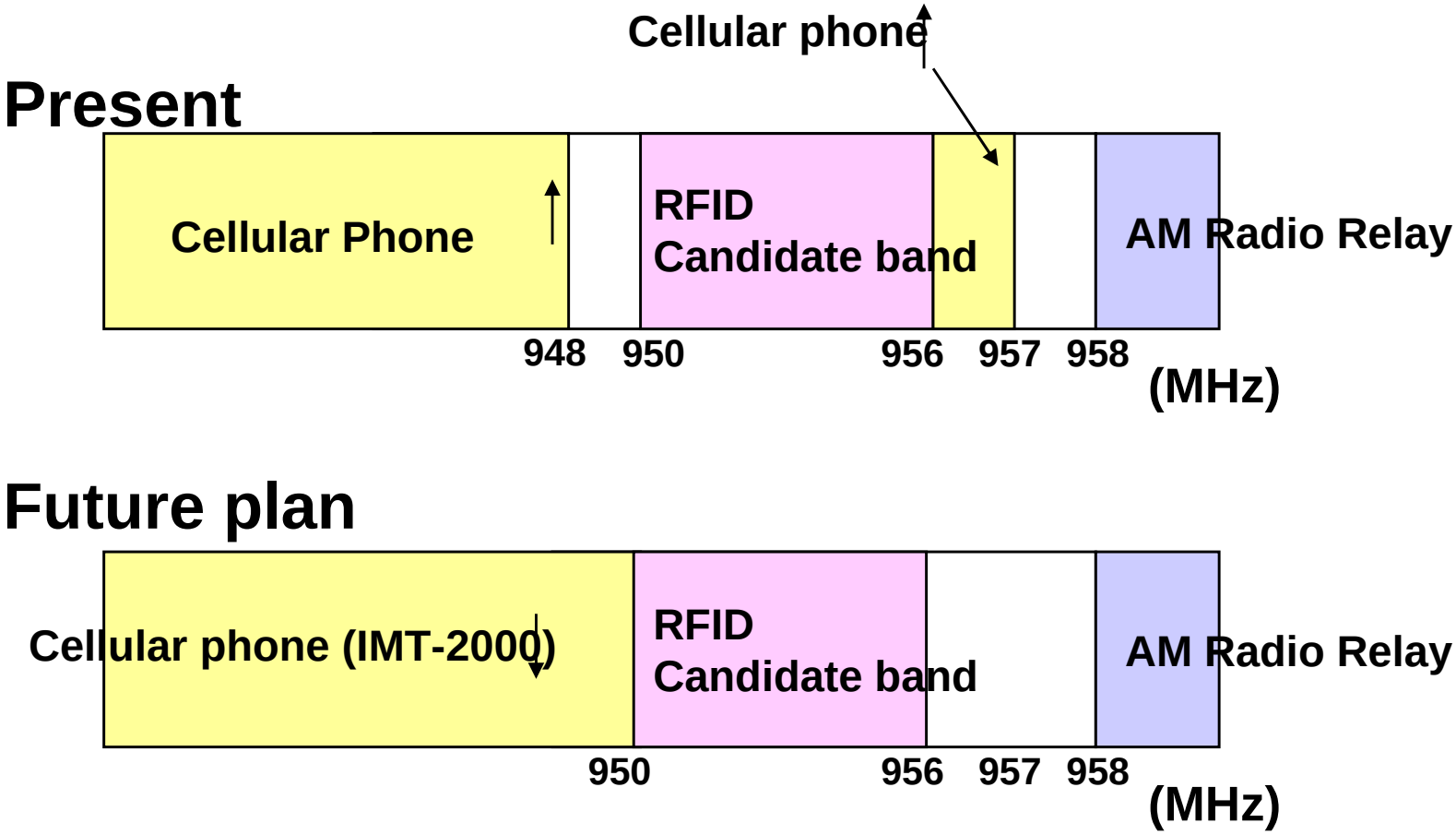
- Region 1 (Europe and Africa)
  - RFID allocation guideline in Short Range Device band (865-868MHz, 869.4-869.65MHz)
  - ERO 70-03, ETSI technical requirements (EN302208, EN302200)
- Region 2 (North and South America)
  - ISM band allocation 902-928MHz
  - FCC15.247 regulates frequency hopping RFID system technical requirements
- Region 3 (Asia Pacific)
  - No allocation
  - Each administration need to establish local radio regulations for UHF RFID

Global frequency allocation chart



Internationally consistent frequency allocation is impracticable at this moment

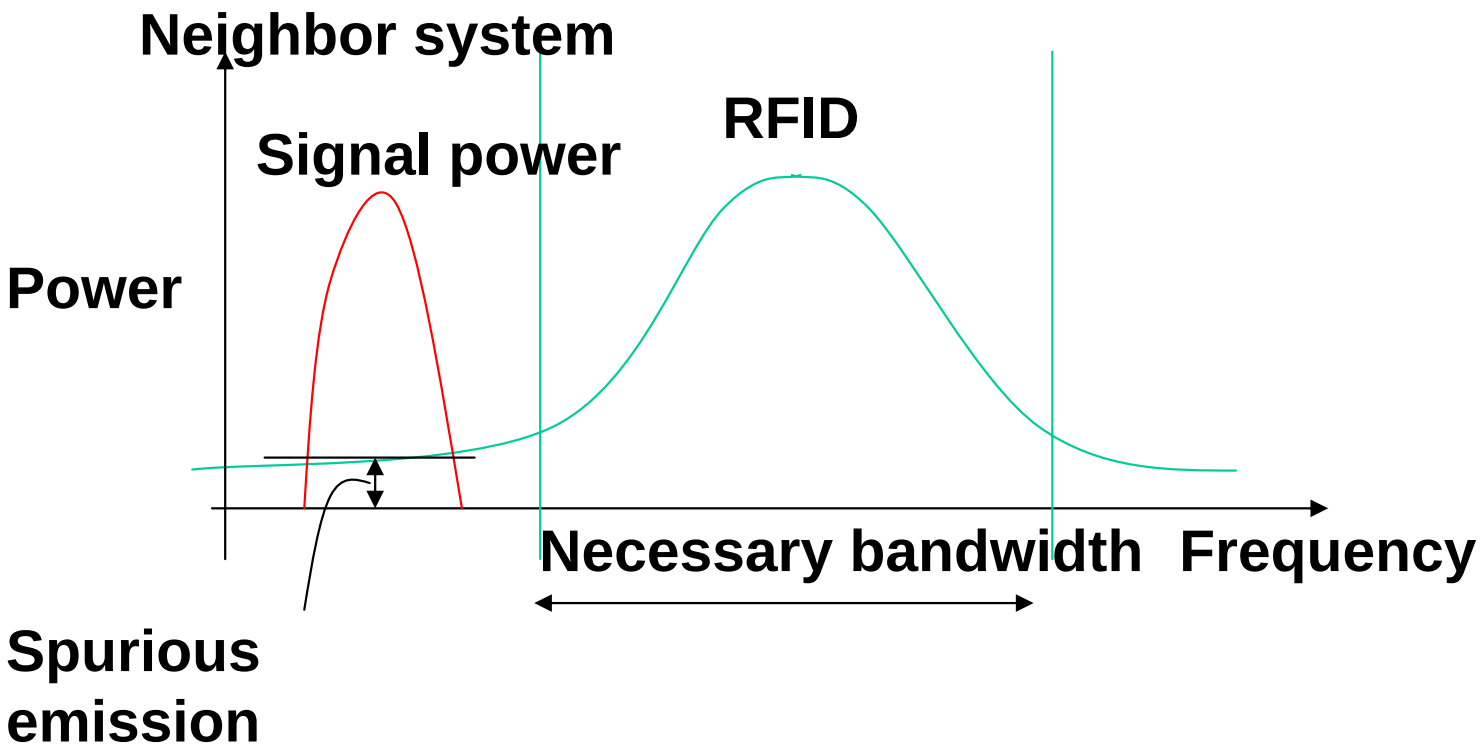
Japan frequency allocation



Fundamental rule of frequency allocation
=Newly allocated radio service (RFID) shall not cause harmful interference to the existing service.

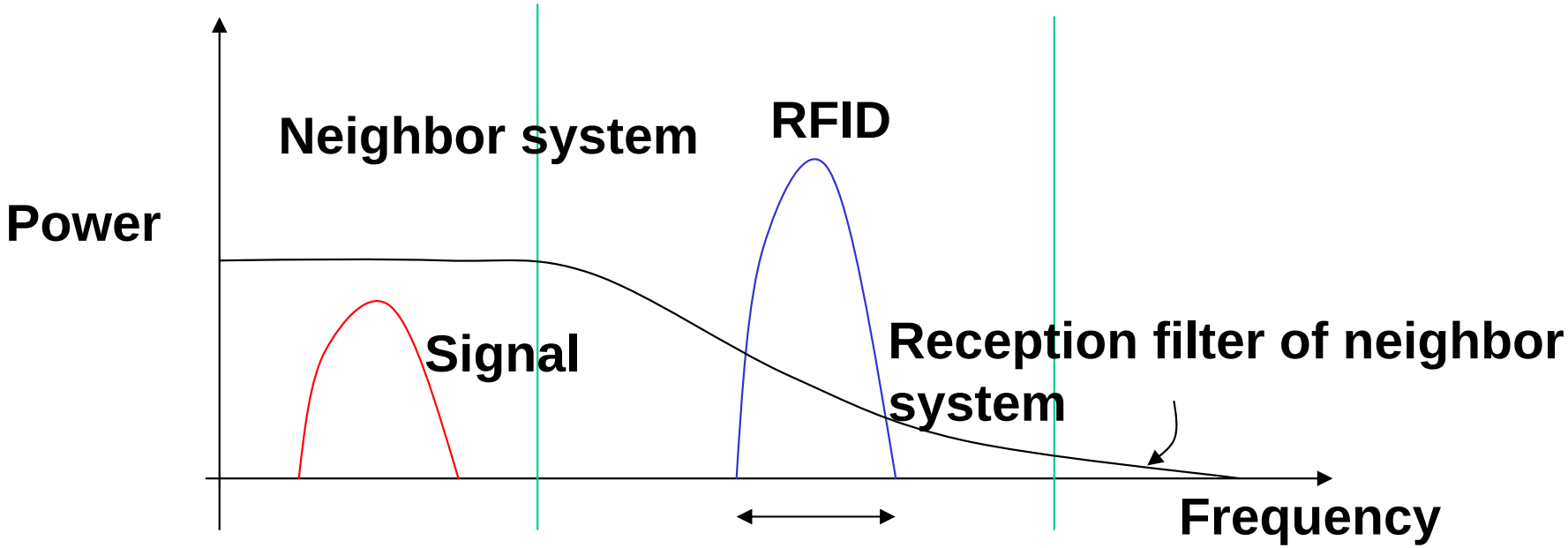
Harmful interference? : Spurious emission

Leaking of RFID power may deteriorate the signal to noise ratio of the existing services.



Harmful interference? : Desensitization

Desired signal of the neighbor services may be suppressed due to the existence of the large RFID power the proximity.



RFID emission eventually is received by the neighboring system

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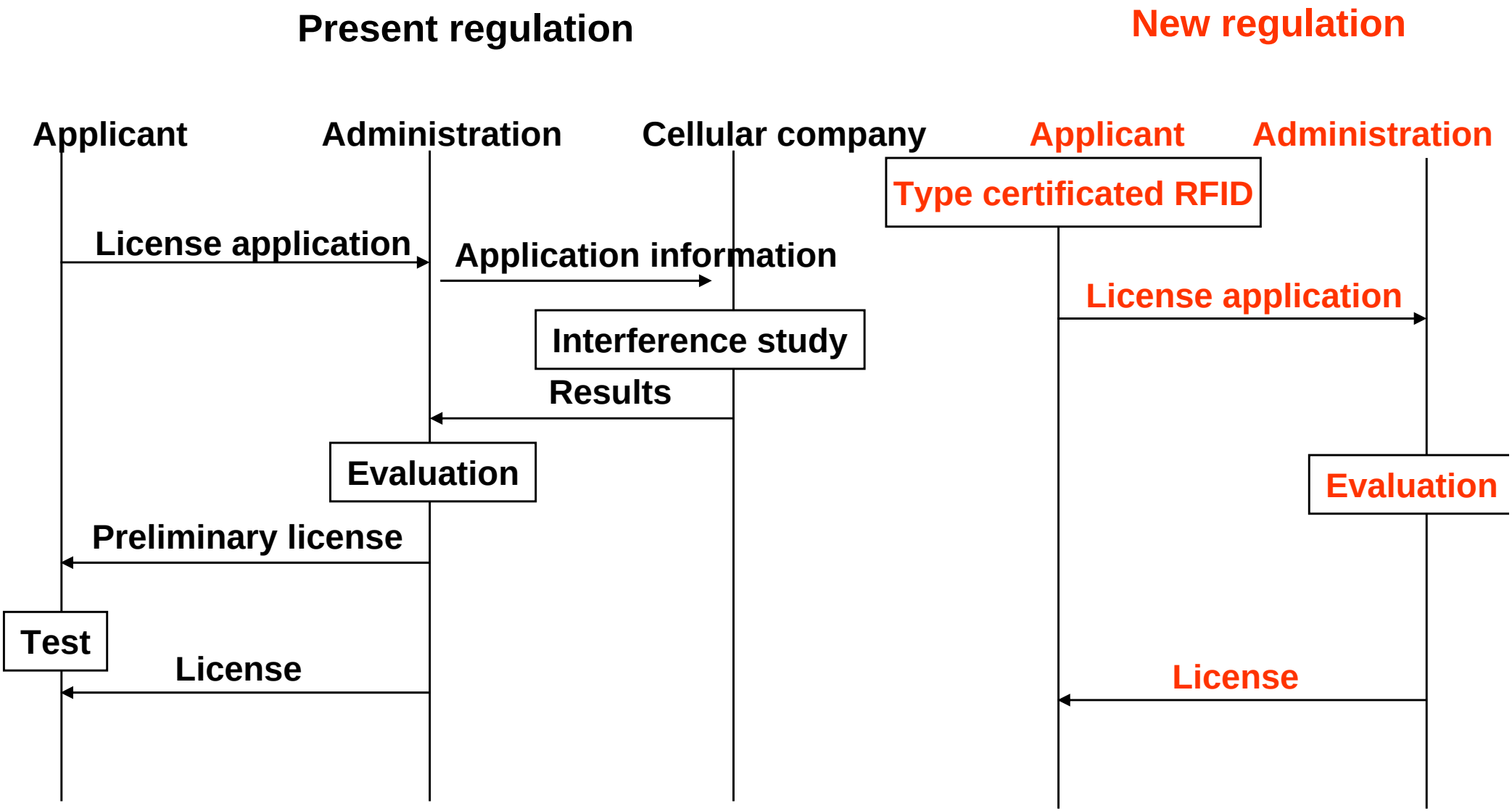
Summary of Japan radio regulation for UHF RFID

- Licensing
  - Fast track license for type certificated RFIDs
- Frequency bandwidth　952MHz～954MHz
- Maximum transmission power　4W (EIRP)

(slated to be issued early in 2005 FY)

Fundamental benefit of new regulation



Significant reduction of time and effort to get license

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Summary

- UHF band RFID features 5-10m reading distance. Primary target is supply chain management. Diverse application will be developed once the technology is in the market.
- Reading accuracy depends on the radio propagation environment as well as tag and reader performance.
- 952-954MHz band will be opened to RFID system in Japan from early FY.2005.