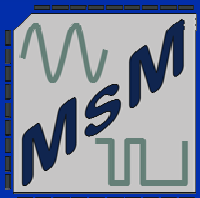


Receiver Planning for a Multi-Standard Front-End

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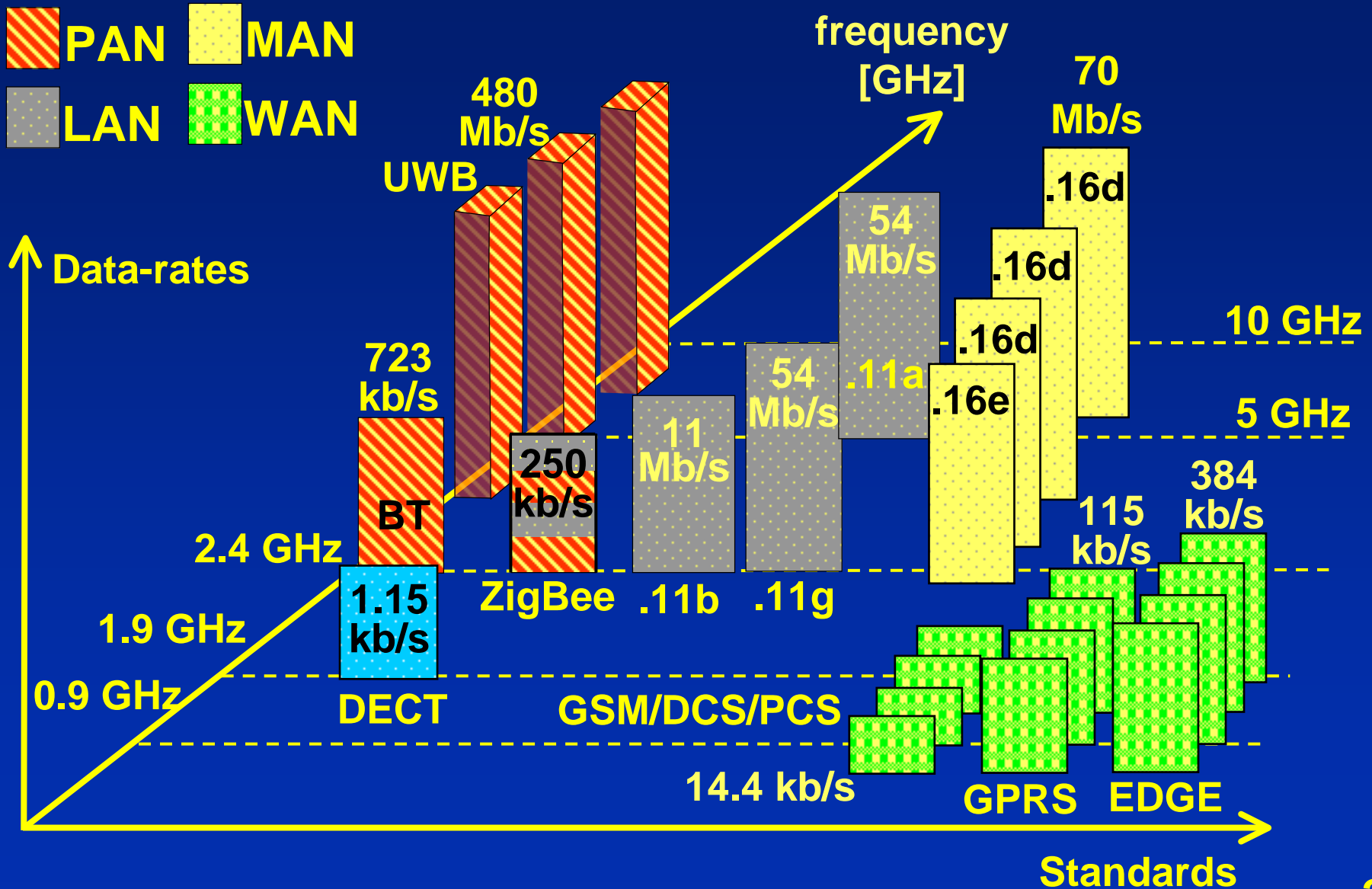
Mixed signal
Microelectronics
(MsM) group



Outline

- Introduction
- Reconfigurable RF building blocks & short time to market & multi-standard receivers
- A design example of a reconfigurable mixer
- Two optimal multi-standard receiver architectures
- Target multi-standard receiver architectures and specifications for Cellular/BT/WLANs standards
- Conclusions

The wireless landscape



Design time, effort & cost

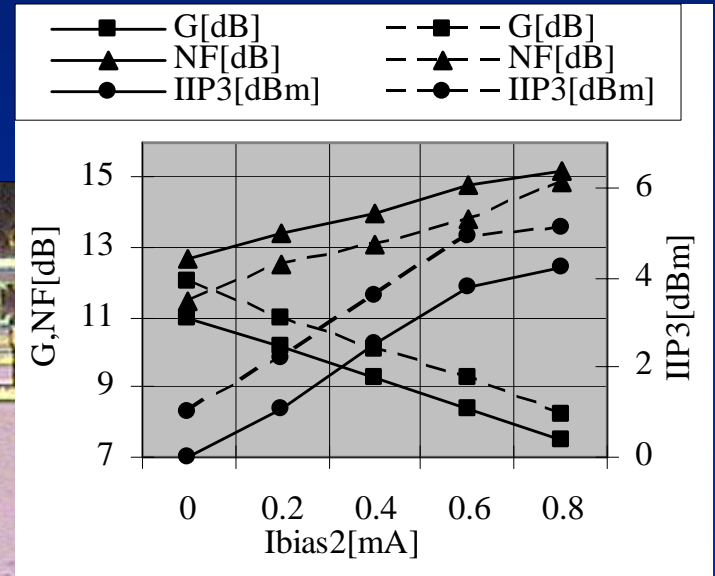
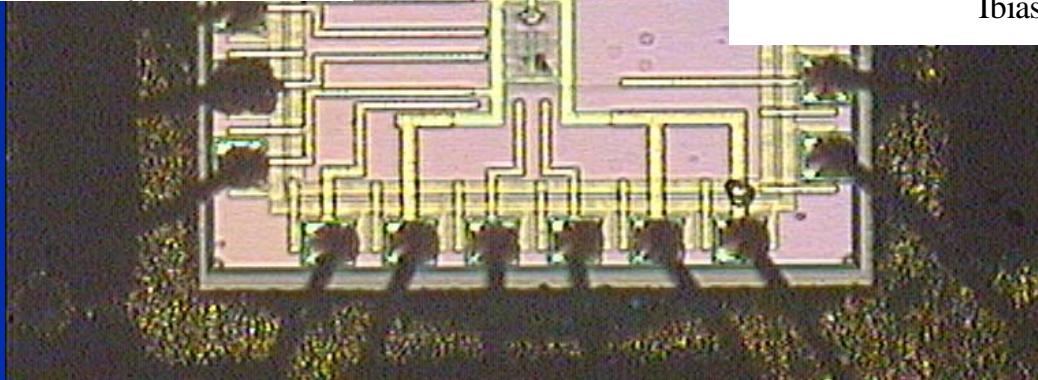
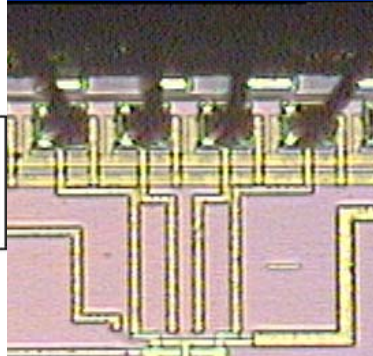
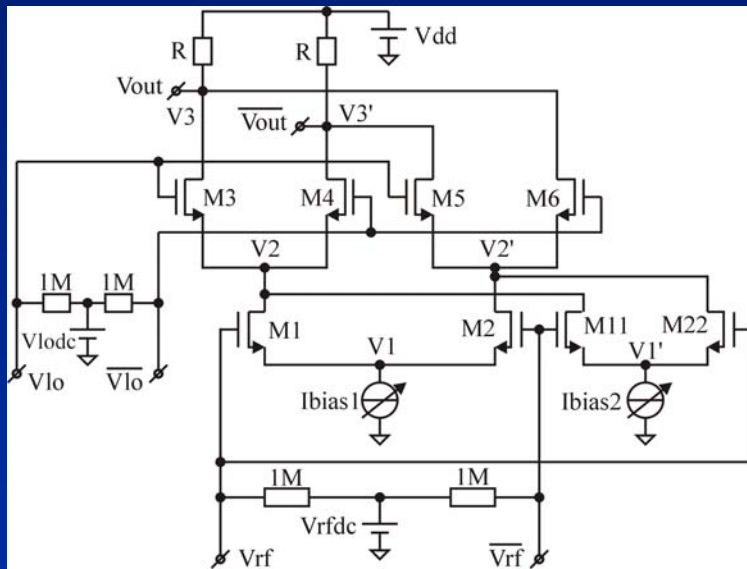
- A fast growth in wireless standards
- Time-to-market pressure
- Implementation in CMOS (SoC)
- CMOS technology scaling
- Increased cost of RF design, e.g. mask sets and wafers

=> Need for more effective RF design:

RECONFIGURABILITY & REUSABILITY

A design example of a reconfigurable mixer

- The adjustable Gilbert cell, 0.25 μ m CMOS

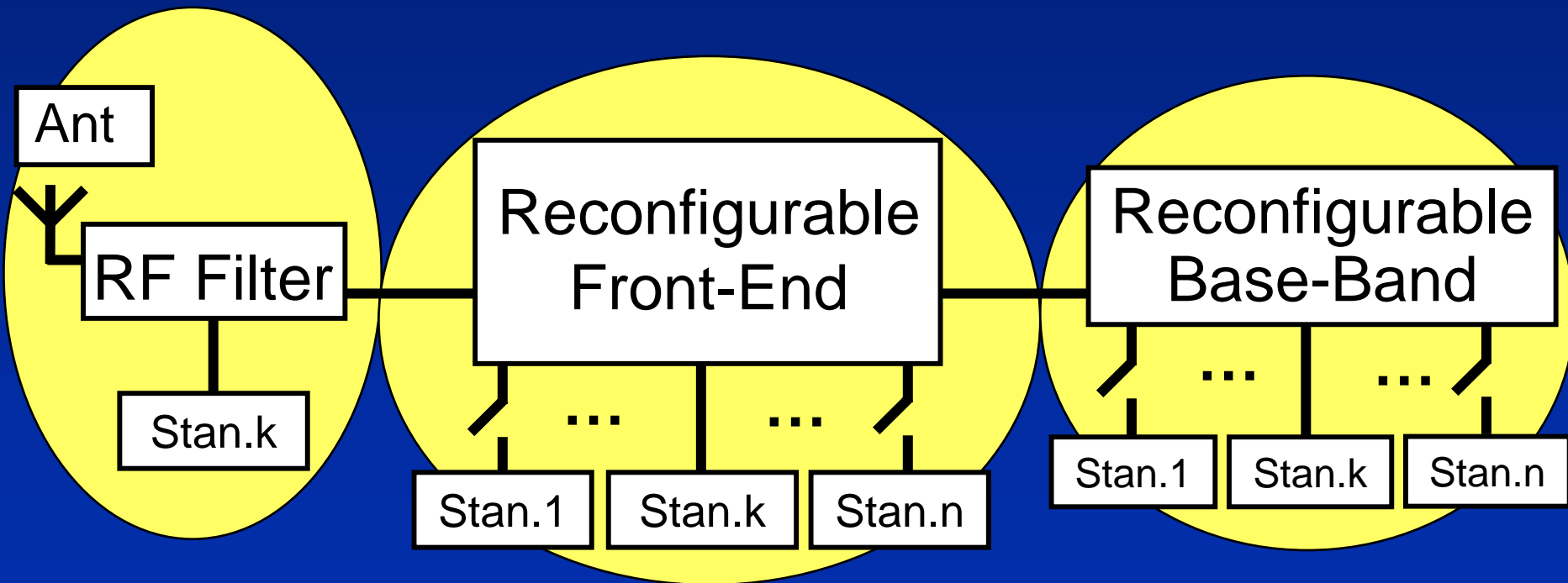


Trends & challenges in the wireless landscape

- Reconfigurable RF building blocks & short time-to-market
- Reconfigurable RF building blocks & multi-standard receivers

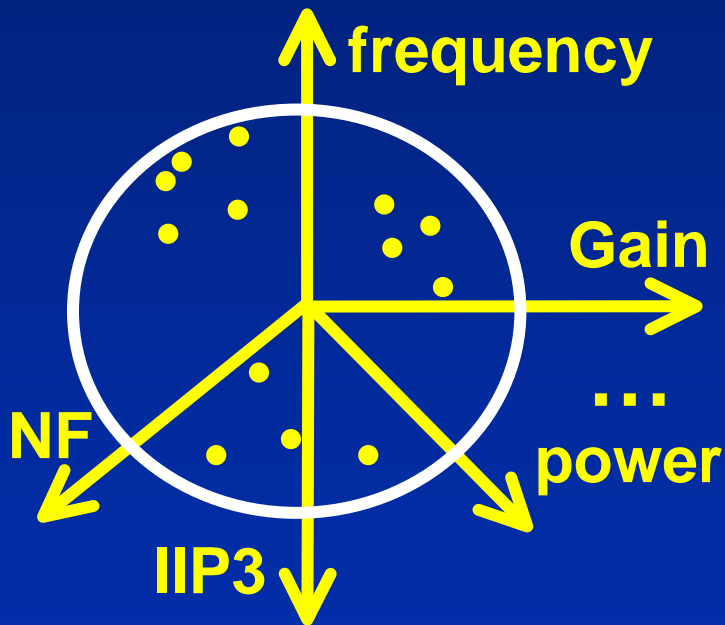
Reconfigurable RF building blocks & short time-to-market

- An efficient implementation

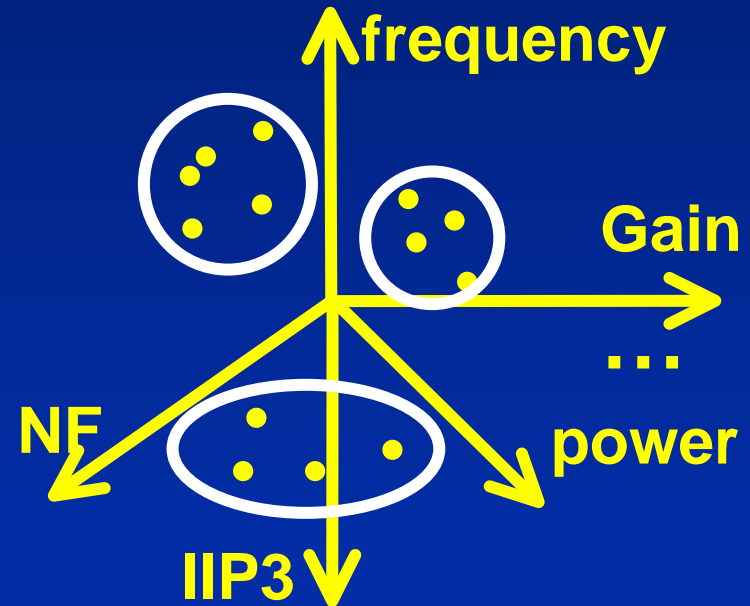


Challenges in reconfigurable RF building blocks & short time-to-market

- An ideal case:
 - One receiver chain for the entire performance space



- A real case :
 - Different receiver chains for each sub-space



Challenges:

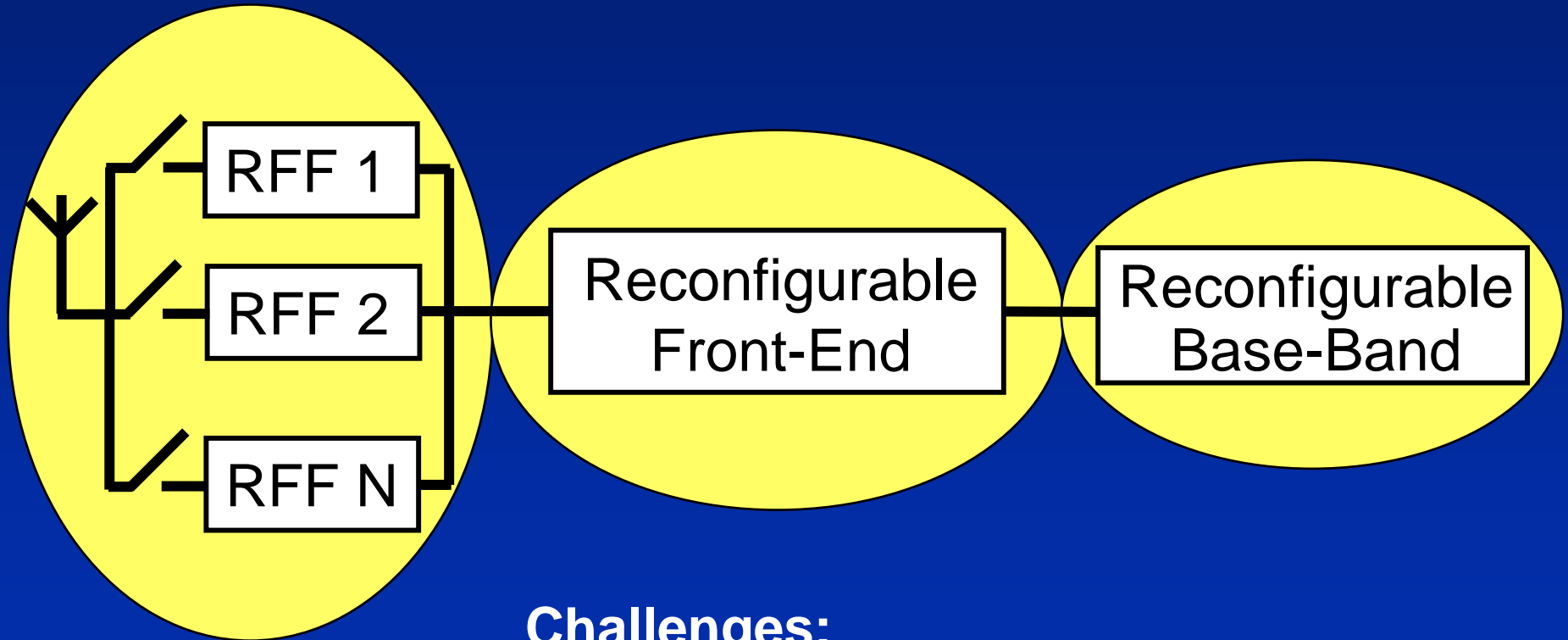
- low cost for a reconfigurable receiver chain
- a wide-band, inductorless reconfigurable receiver

Reconfigurable RF building blocks & multi-standard receivers

- The performance space of RF building blocks is determined by an application
- A multi-standard receiver can require non-concurrent standards
- A multi-standard receiver can require concurrent standards

A non-concurrent multi-standard receiver

- A straight forward implementation

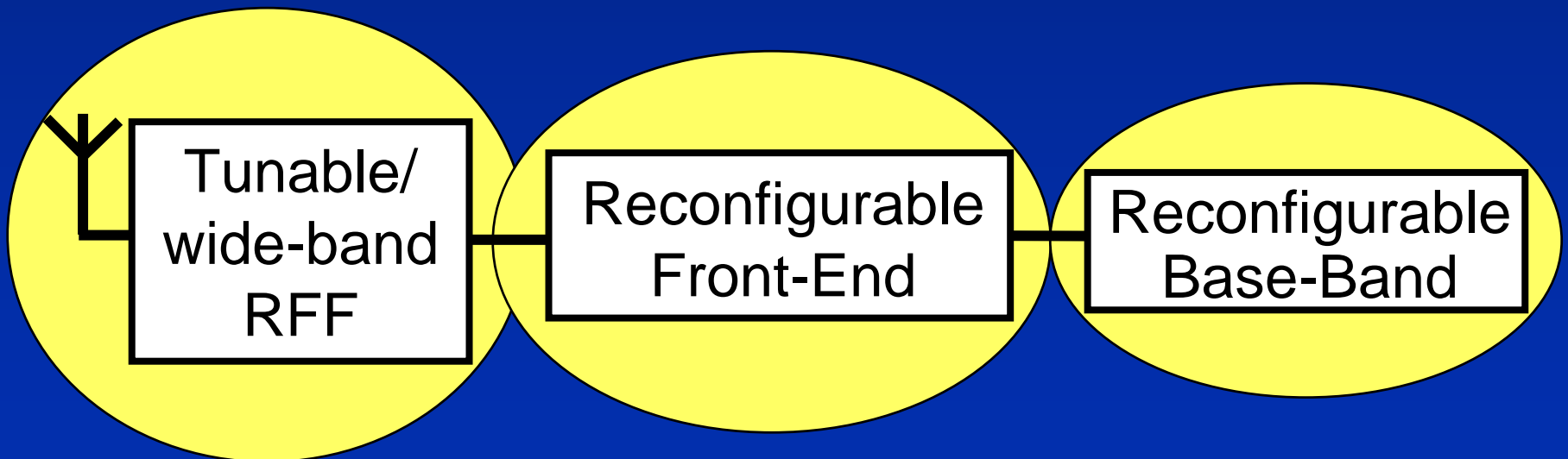


Challenges:

- low cost for a reconfigurable receiver chain
- a wide-band, inductorless reconfigurable receiver

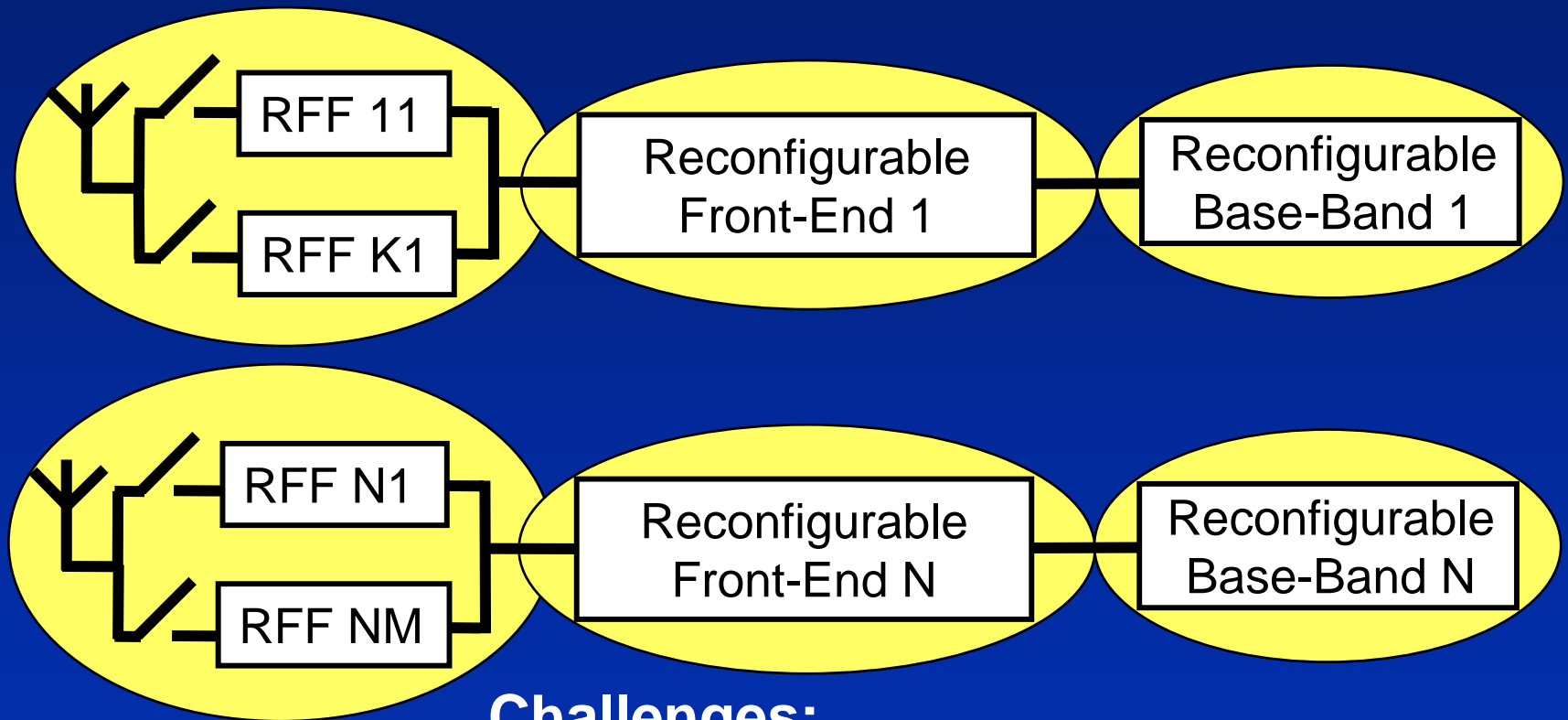
Additional challenges in the non-concurrent multi-standard receiver

- + The number of RF filters decreases
- Additional constraints on the linearity of the reconfigurable receiver



A concurrent multi-standard receiver

- A straight forward implementation:
 - N different paths for N concurrent standards

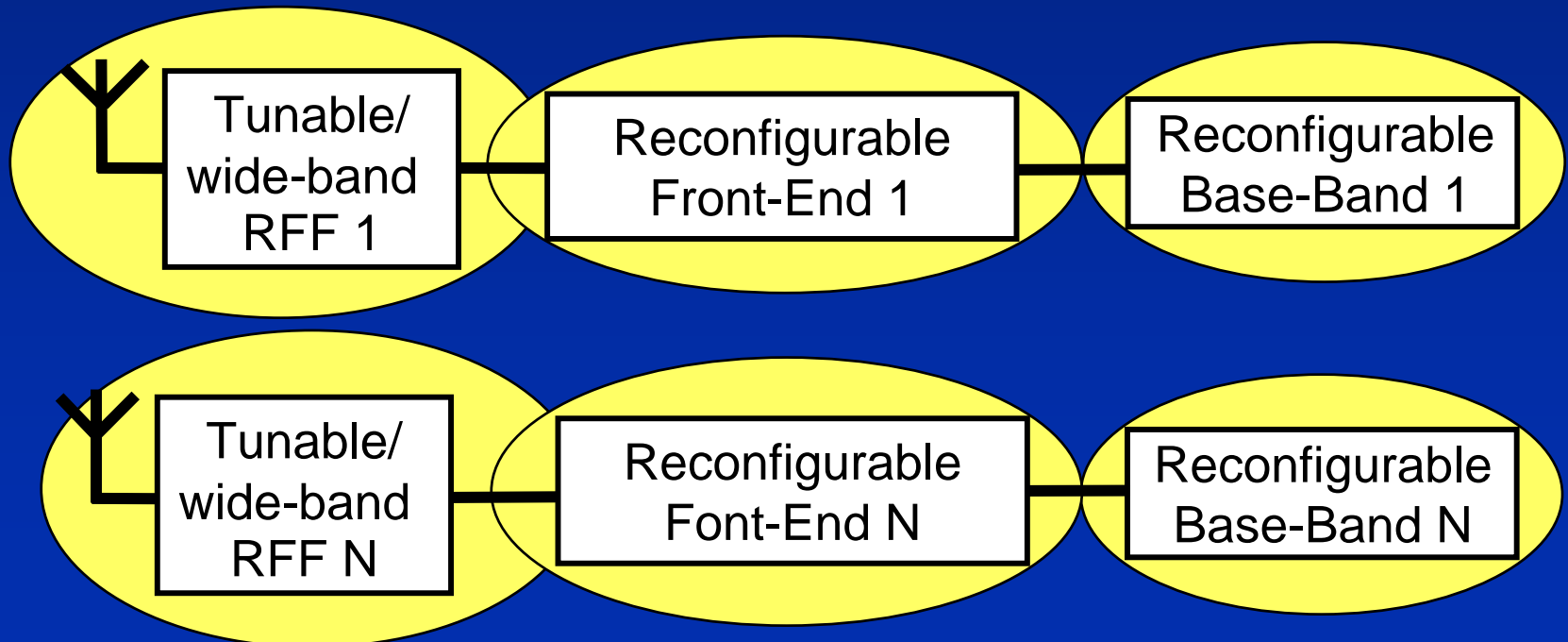


Challenges:

- **low cost for a reconfigurable receiver chain**
- **a wide-band, inductorless reconfigurable receiver**

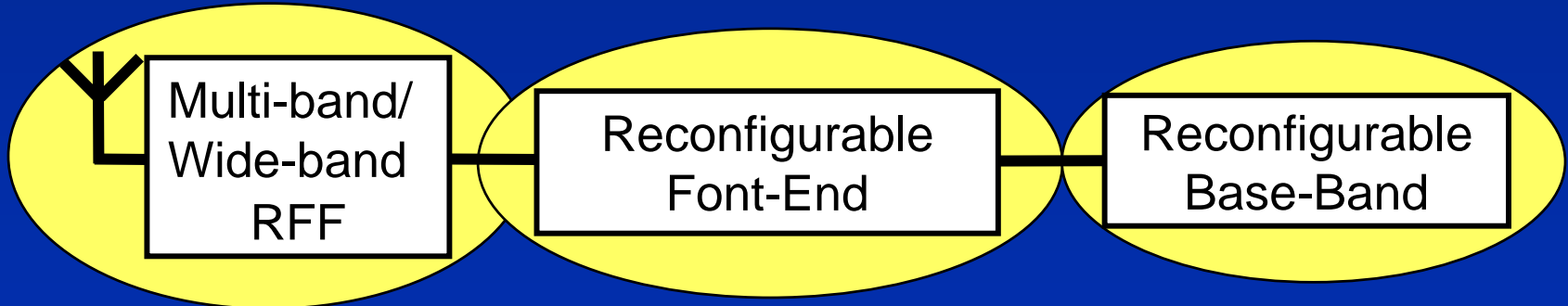
Additional challenges in the concurrent multi-standard receiver (1)

- ++ The number of RF filters decreases
 - Additional constraints on the linearity of the reconfigurable receiver



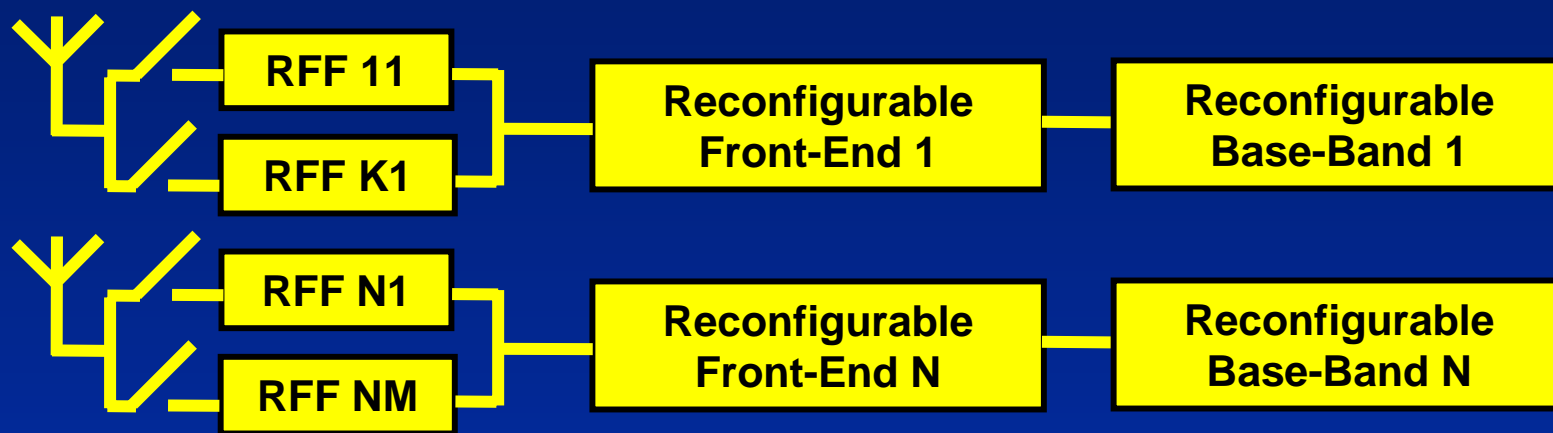
Additional challenges in the concurrent multi-standard receiver (2)

- + Cost & the number of RFF further decrease, but slightly
- - Very strict constraints on the reconfigurable receiver:
 - (1) a very linear multi-band reconfigurable receiver
 - (2) high speed ADCs

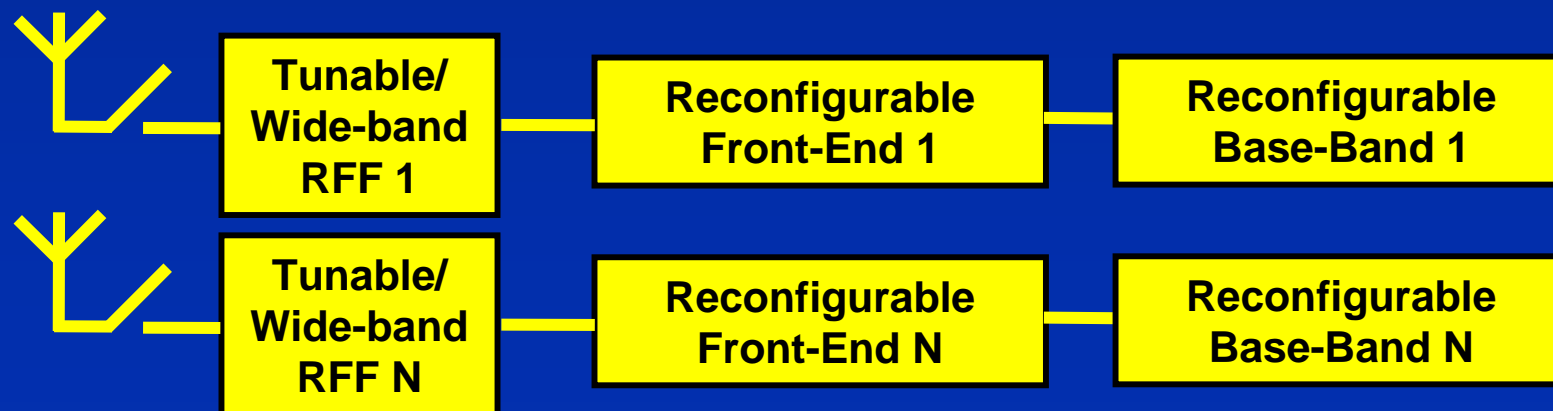


Optimal multi-standard implementations: cost versus performance degradation

- The multi-standard architecture 1



- The multi-standard architecture 2

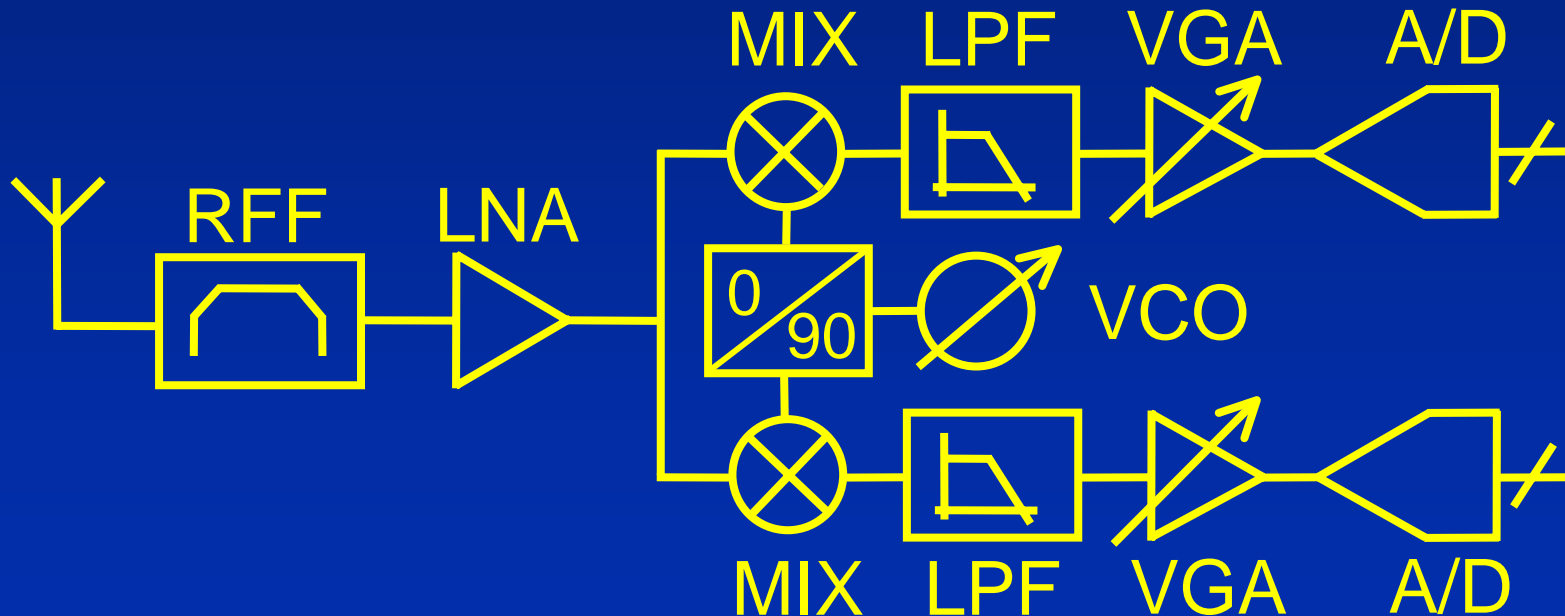


The concurrent multi-standard receiver: a study case

- The multi-standard receiver consists of:
 - GSM850MHz, E-GSM, DCS, PCS
 - WLAN a/b/g
 - Bluetooth (BT)
- The application requires concurrent standards:
 - GSM850/E-GSM/DCS/PCS & BT
 - GSM850/ E-GSM/DCS/PCS & WLAN a/b/g
 - GSM850/ E-GSM/DCS/PCS & WLAN a/b/g & BT

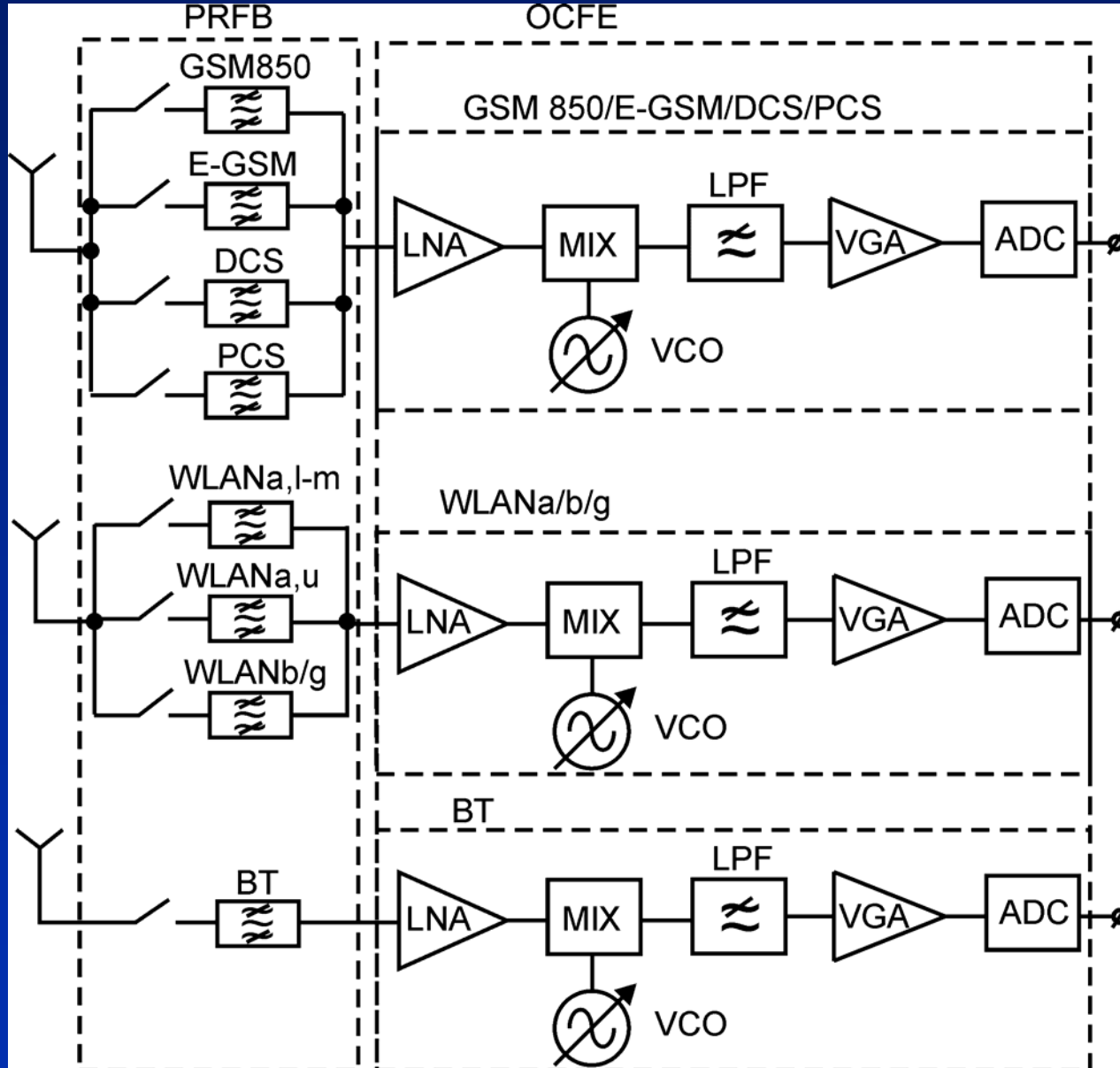
A common receiver architecture

- A common receiver architecture has to support standards in the multi-standard receiver:
 - A zero IF architecture for WLAN a/b/g
 - A low IF architecture for GSMs/DCS/PCS/BT



- Image suppression in digital domain

The target multi-standard architecture (1)

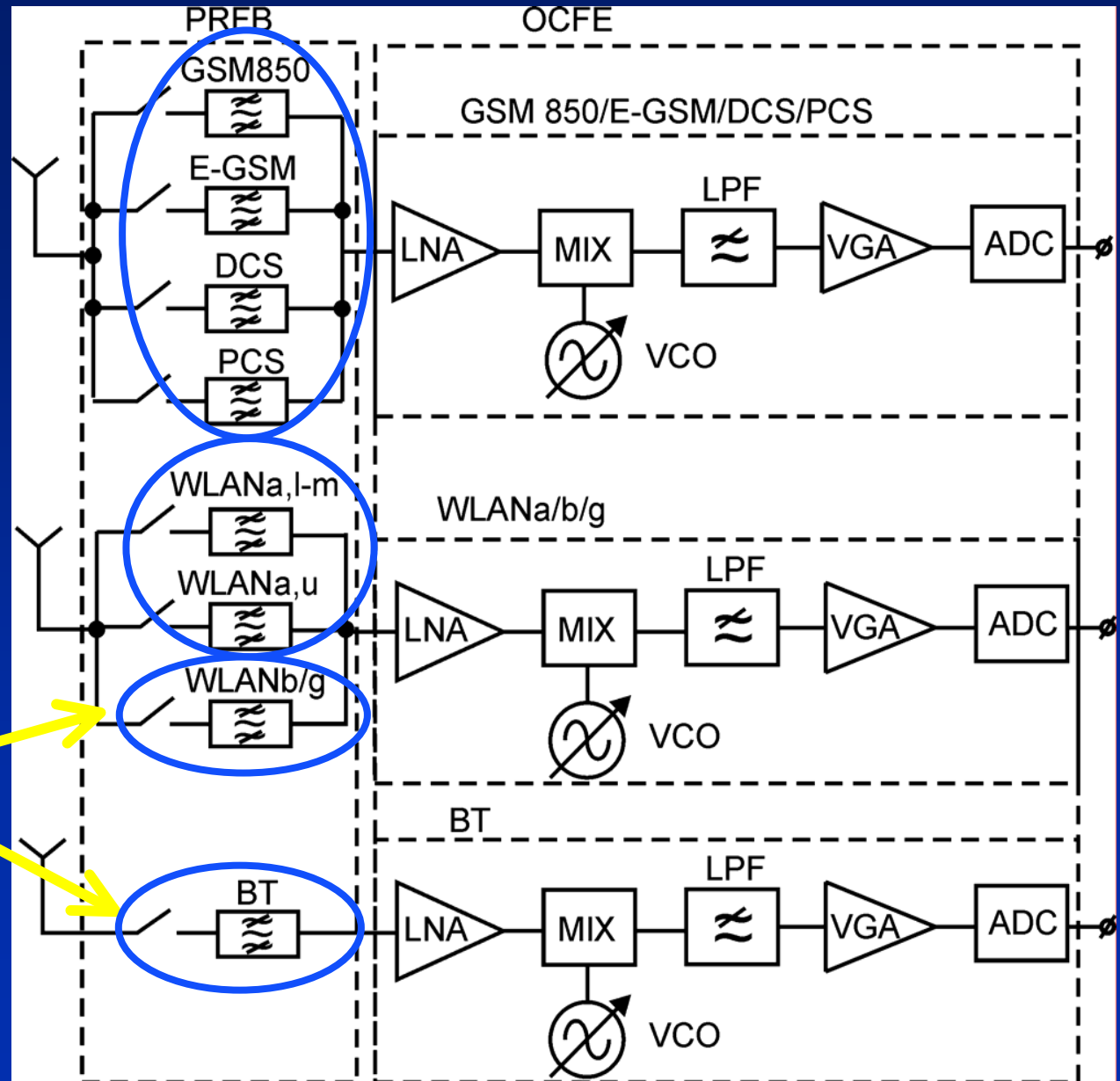


The first challenge

- Target specification (1)

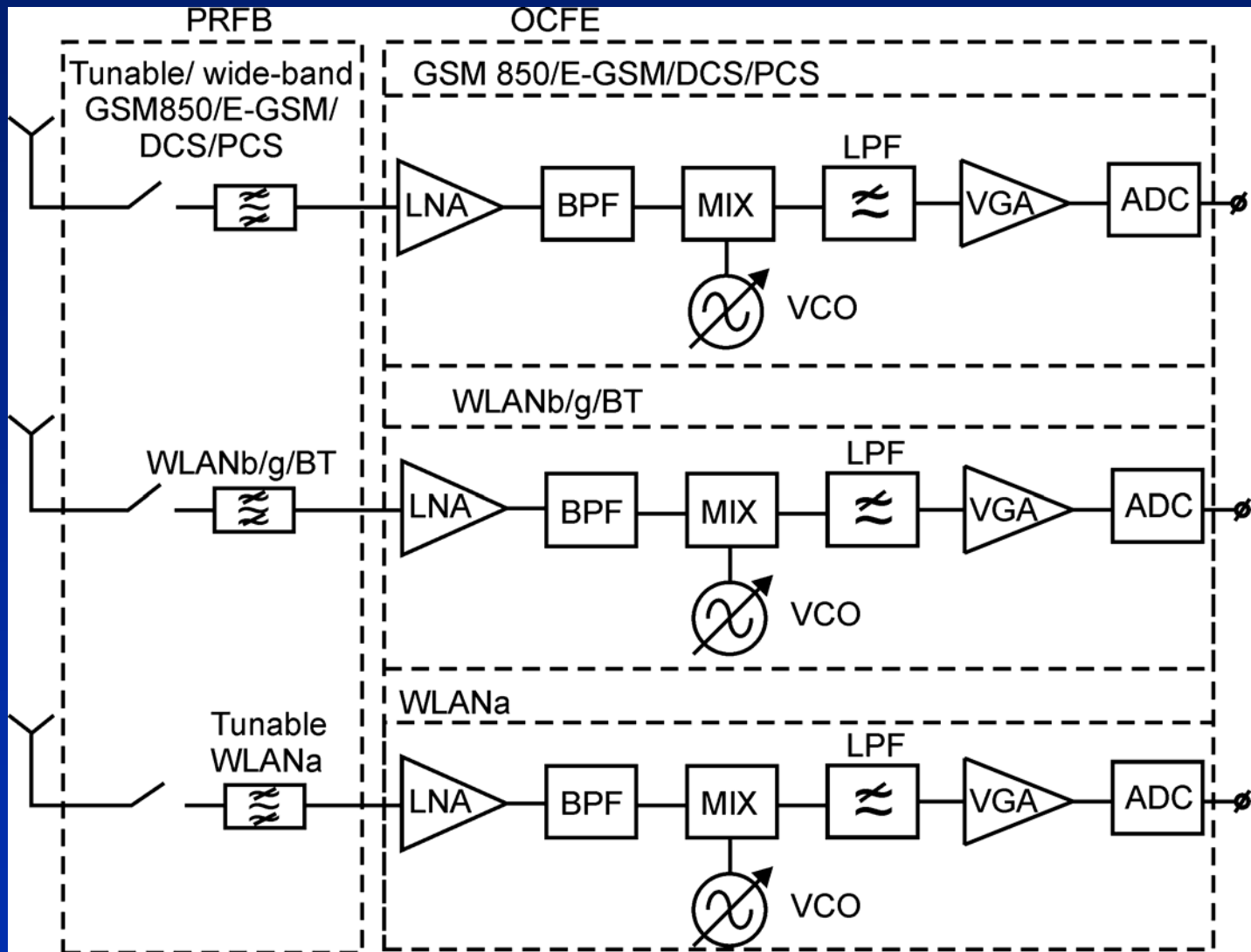
Standard	Minimum frequency [MHz]	Maximum frequency [MHz]	Channel bandwidth [MHz]	System gain [dB]	Noise Figure [dB]	IIP2 [dBm]	IIP3 [dBm]
GSM	860	895	0.2	73	8	48	-18
E-GSM	921	960	0.2	73	8	48	-18
DCS	1805	1880	0.2	73	8	48	-18
PCS	1930	1990	0.2	73	8	48	-18
WLAN a	5150	5825	20	54	7.8	7	-17.5
WLAN b	2400	2500	25	48	14	21.5	-5
WLAN g	2400	2500	20	54	7.8	7	-17.5
BT	2402	2480	1	54	21	9	-15

Cost



- Doubling RFF
- + The same channel bandwidth

The target multi-standard architecture (2)



The second challenge

- Target specification (2)

Standard	System gain [dB]	Noise Figure [dB]	1 dB [dBm]
GSM	73	8	-10
E-GSM	73	8	-10
DCS	73	8	-10
PCS	73	8	-10
WLAN a	54	7.8	-10
WLAN b	48	14	-25
WLAN g	54	7.8	-25
BT	54	21	-27

Conclusions

- Reconfigurable building blocks are key to support short- time-to-market & multi-band systems
- Two optimal multi-standard receiver architectures were presented
- Challenges in these multi-standard architectures are:
 - a reconfigurable receiver chain is needed to support every standard in the receiver chain
 - a decrease in the number of RF filters & reuse of RF filters is needed, this requires higher receiver linearity
- The front-end specifications for Cellular/BT/WLANs standards for the optimal architectures were presented