MICROTUNE

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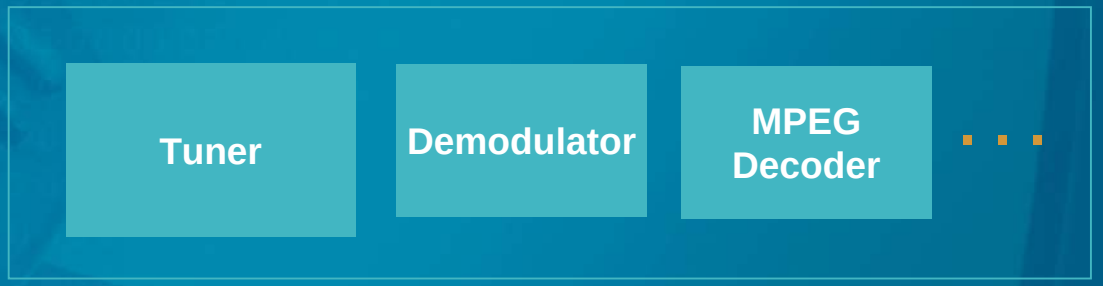
What is a Tuner anyway?
"Tuners" vs. "tuners"

"Tuner"

- **Consumer device**
- **Radio frequency in**
- **Multimedia out to display**



"tuner"

- **Component in a consumer device**
- **RF in**
- ***Intermediate frequency* out to demodulator**

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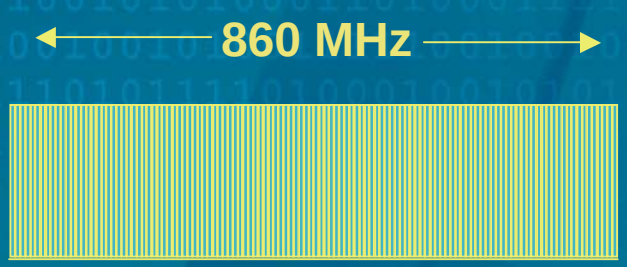
Why do we need “tuners” anyway?
Isn’t everything going digital?



Sampling rate needed: ~2 Gsps
>12 bits
2 watts power dissipation

Analog-to-Digital Converter (?)

Demodulator

MPEG Decoder

. . .

Processing all the input channels digitally would require a very powerful (and expensive) Analog-to-Digital converter

Why do we need “tuners” anyway?
Isn’t everything going digital?

Sampling rate needed: 2 Gsps
~10 bits
1.5 watts power dissipation

Filter → | → Analog-to-Digital Converter (?) → Demodulator → MPEG Decoder → . . .

One channel
between 54 and 860 MHz

Filtering a single RF channel would reduce bits required,
but not sampling rate

Why do we need “tuners” anyway?

RF tuners greatly simplify A/D converter requirements

Sampling rate needed: 25 Msps
~10 bits
<0.1 watts

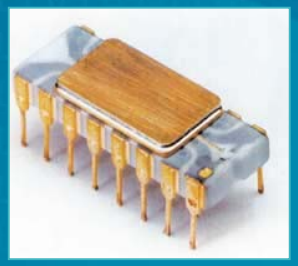
One channel
At “Intermediate Frequency”
(typically 36-44 MHz)

Tuners greatly simplify the analog-to-digital conversion in receivers making it practical to integrate A/D converter in demodulator/decoder

Tuner IC's are here!

Why did it take so long?

1946: First digital computer (ENIAC) 17,468 vacuum tubes

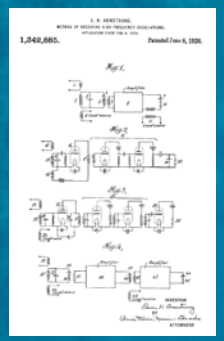


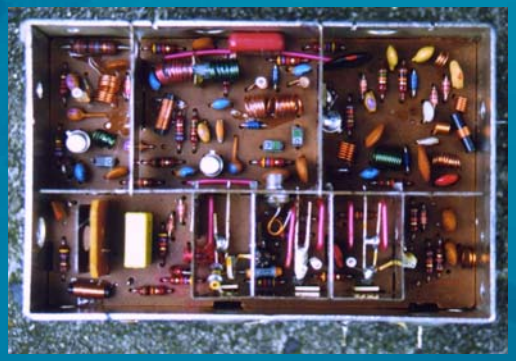
1971: First IC computer (Intel 4004) 2,300 transistors

2004: 320 million transistors

1900		1920		1940		1960		1980		2000	

1919: Armstrong patent Basic dual-conversion tuner architecture





Discrete component Tuner modules

1998: First practical IC tuner

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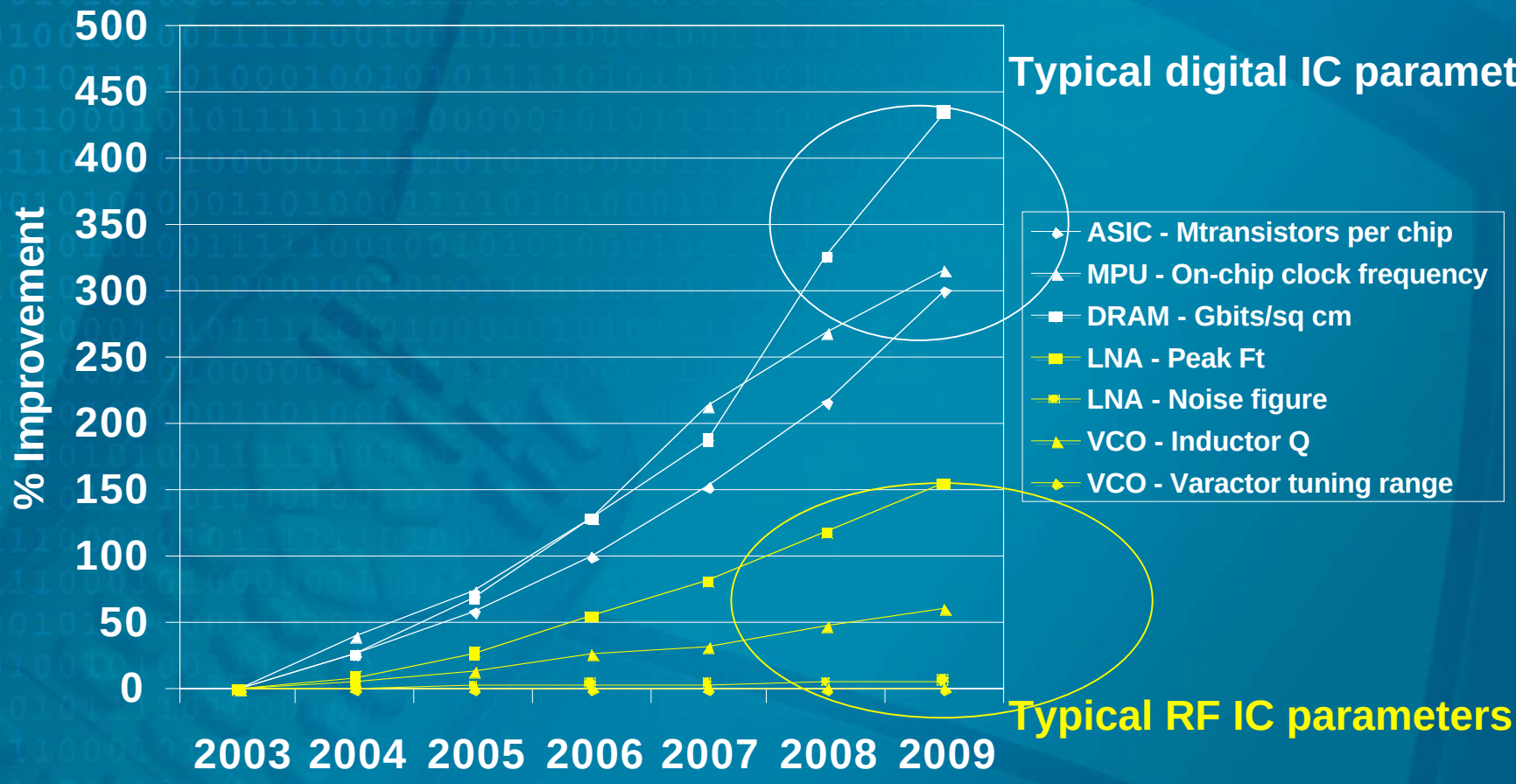
Typical Technology Projections

Analog/RF technology typically defies Moore's Law



Source: 2004 International Technology Roadmap for Semiconductors

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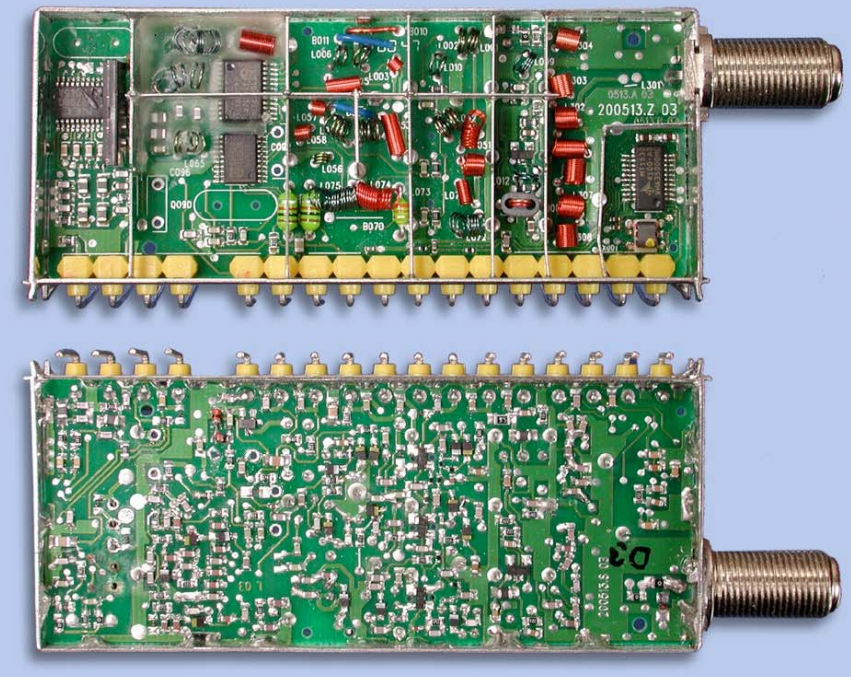
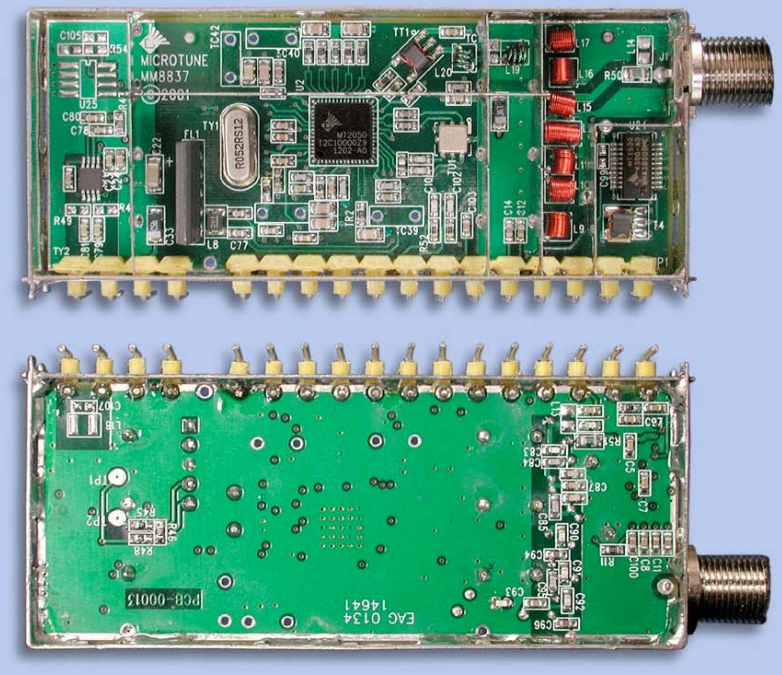
IC Tuners offer a higher degree of integration
Example – Simplified module design

Discrete module



Tuner IC-based module



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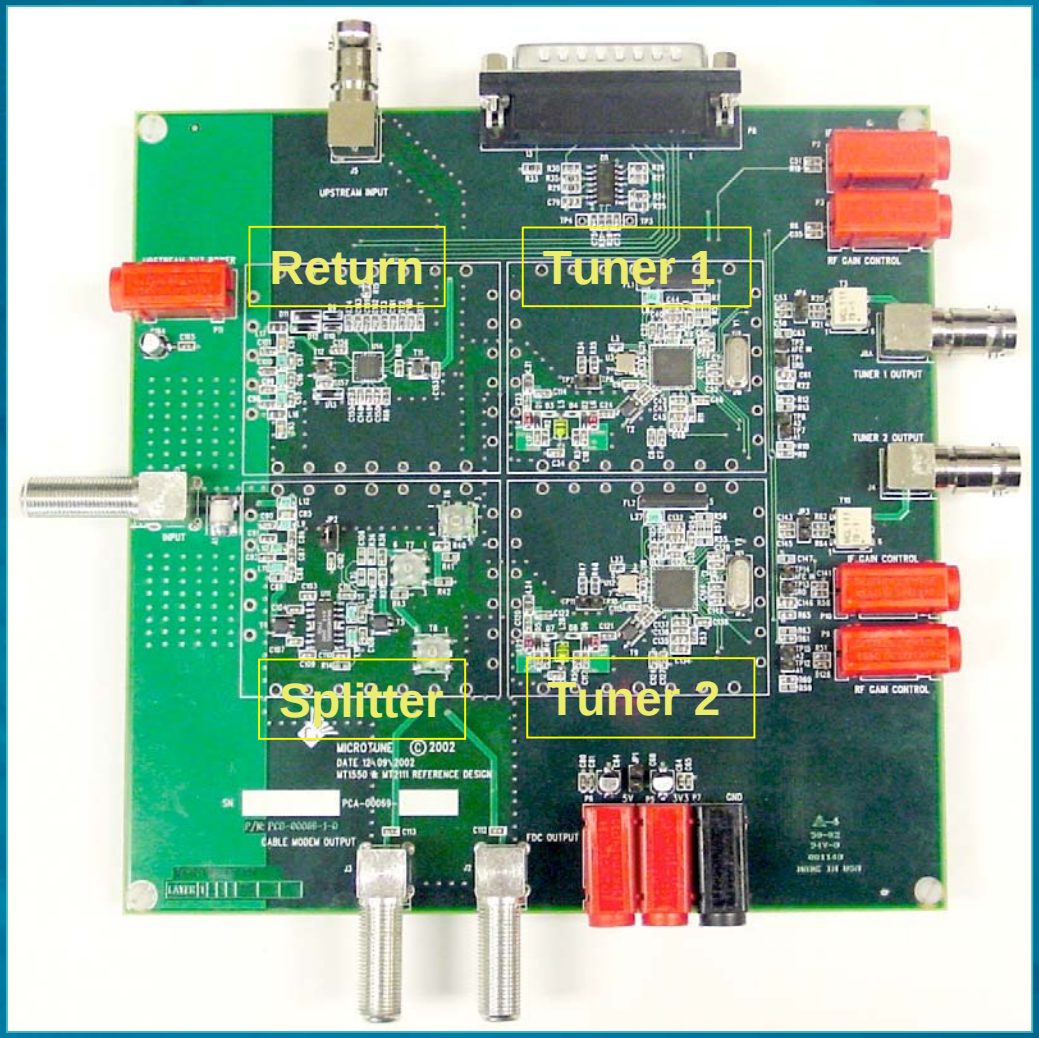
… and enable multi-tuner on-board designs

Bi-directional dual-tuner design in 10 x 10 cm footprint

Upstream In

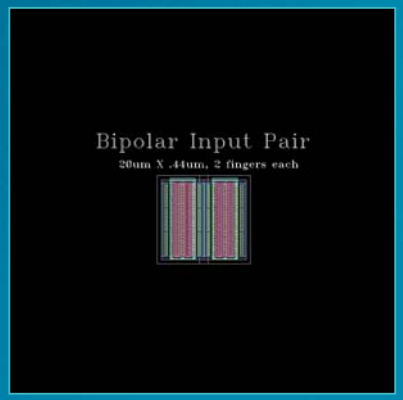
RF Input

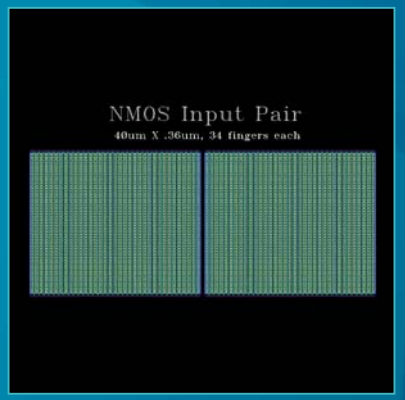


Combining RF and digital blocks might not make sense

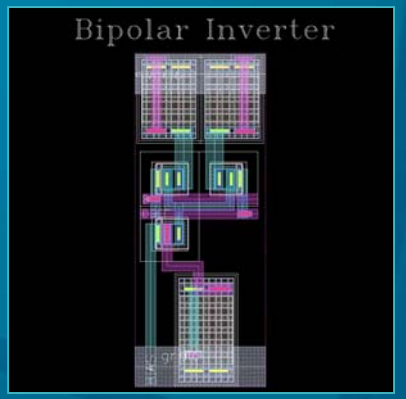
Digital and RF IC's don't normally **scale the same way**

RF example:
LNA's are usually bigger in digital processes



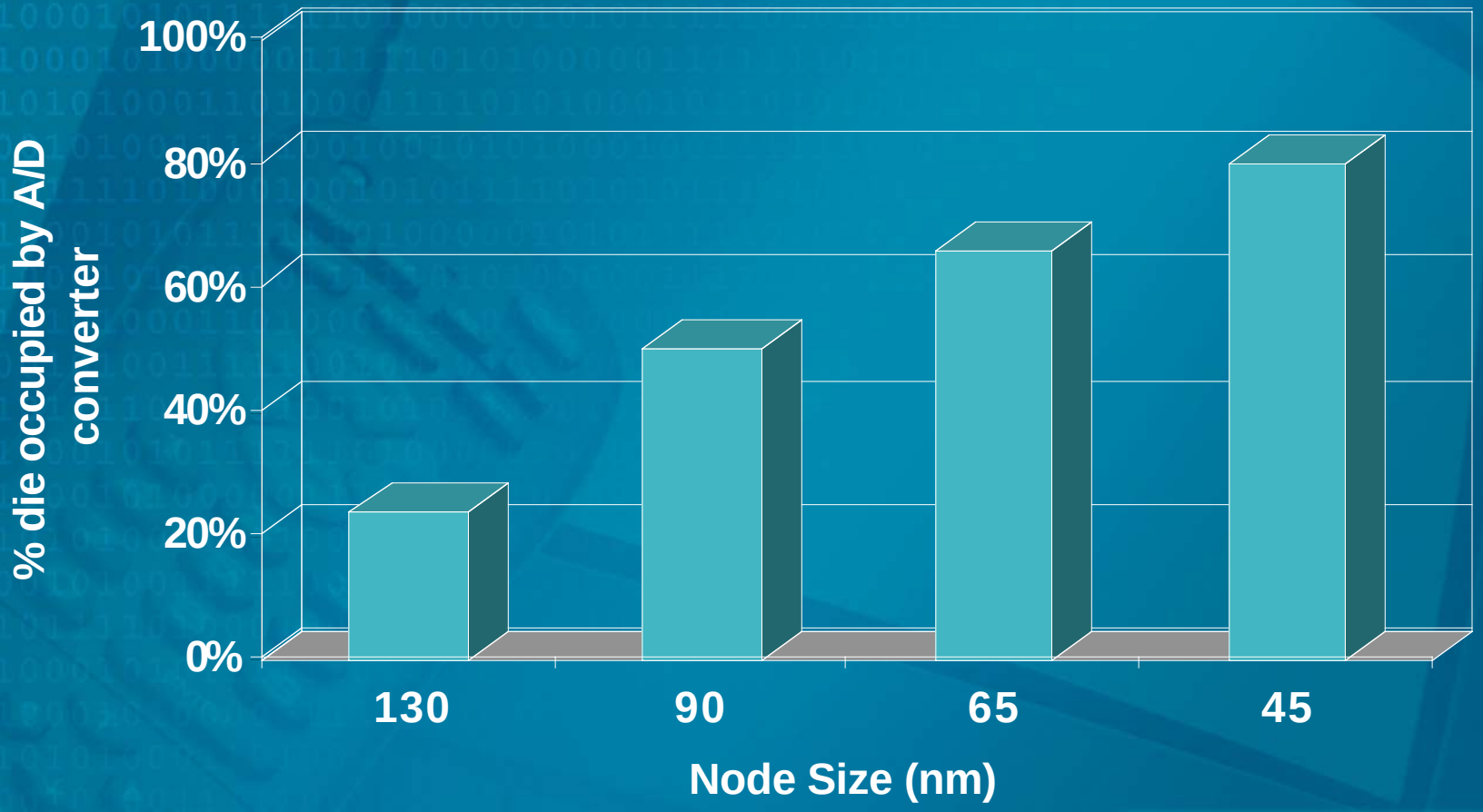


Digital example:
While logic components are usually bigger in RF processes



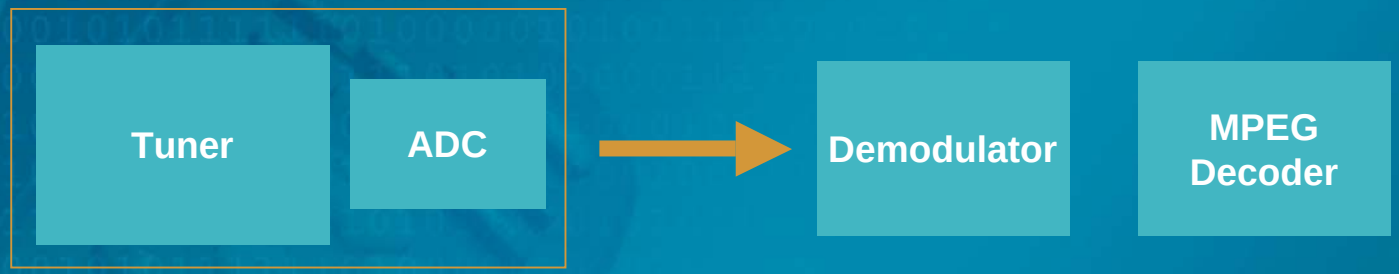
Demodulator IC's could end up mostly analog!

Example: A/D converter as % of die in QAM demodulator

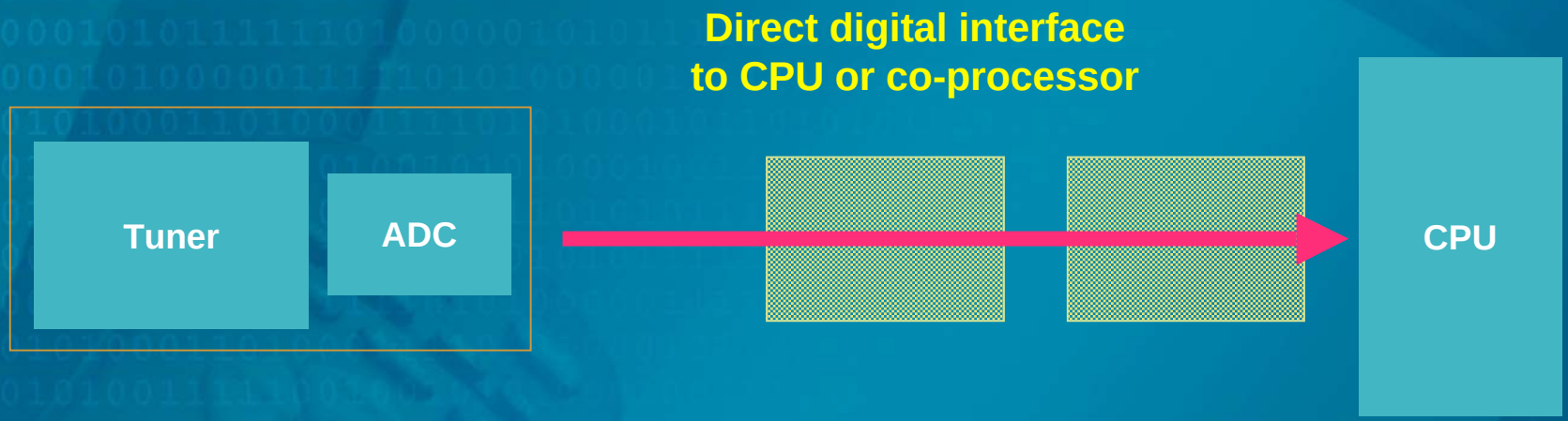


Digital Tuner Concept

Direct digital interface to demodulator

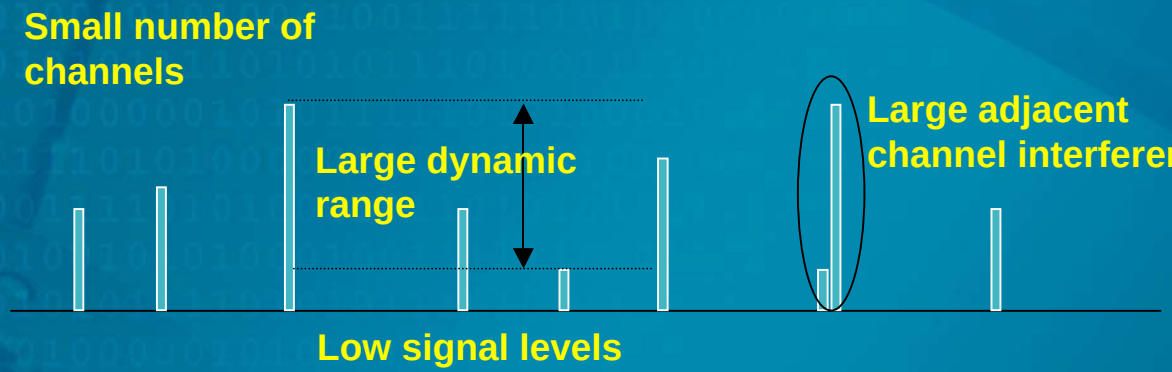


Digital Tuner Concept
... or soft demodulator/decoding in some PC apps



Terrestrial/Cable Receiver Convergence
Tuner solution is challenging

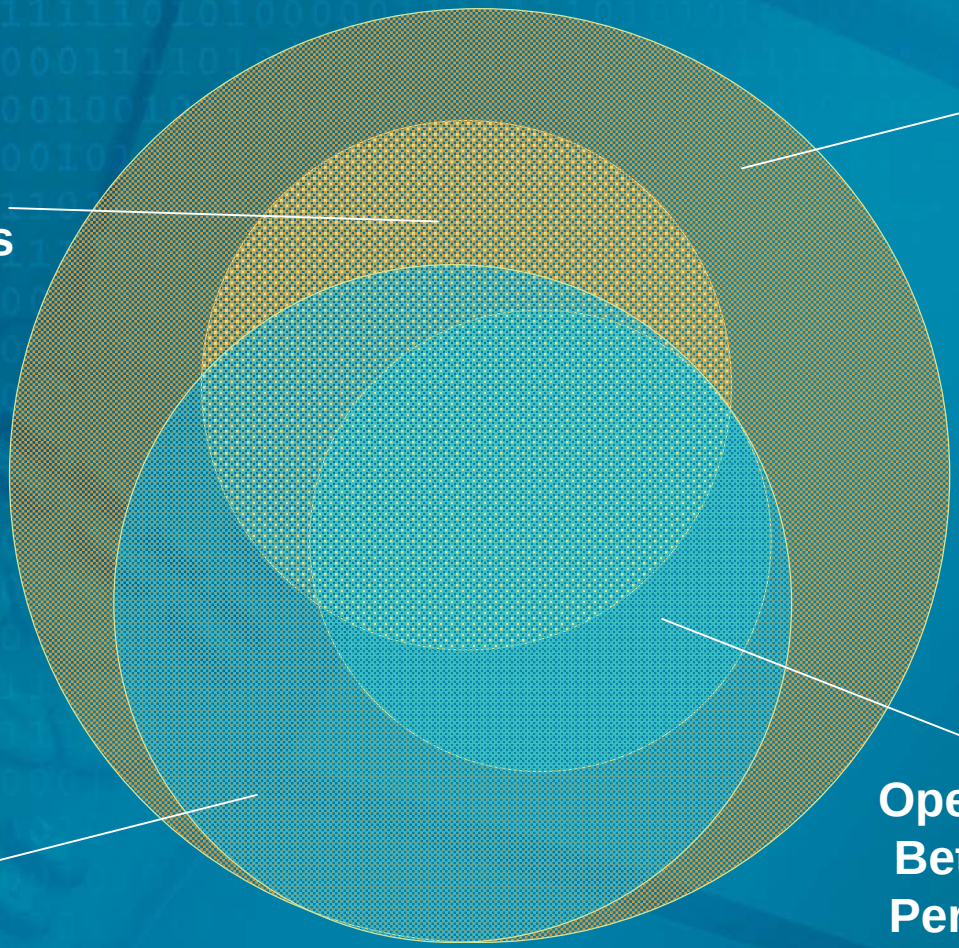
Off-air channels



Cable channels

Terrestrial/Cable Receiver Convergence

Also complicated by standards and specifications



Minimal cable specs are not good enough

"Plug-and-Play" TV's may not work in a real network

	OpenCable/SCTE 40 Specification	Uni-Dir PICS Specification
CTB	-63 dBc	*Not Specified*
CSO	-60 dBc	*Not Specified*
XM	-57 dBc	*Not Specified*
Adjacent channel rejection	60 dB	*Not Specified*
Phase noise	-88 dBc/Hz	-86 dBc/Hz
Carrier-to-interference	-53 dBc	*Not Specified*
Chroma-luma delay	< 170 ns	*Not Specified*
Image rejection	60 dBc	*Not Specified*

Summary

- Tuners will probably be with us for a long time
  - Broadband A/D conversion is not yet practical
- IC tuners are here!
  - Simplify existing designs and enable complex on-board designs
- We may see a shift of some demodulator/decoder functions into the tuner, but probably not the other way around
  - Main candidate: Input A/D converter
- Terrestrial/cable convergence is complicated by multiple standards/performance tiers
  - Digital cable ready performance as currently defined may be underspecified