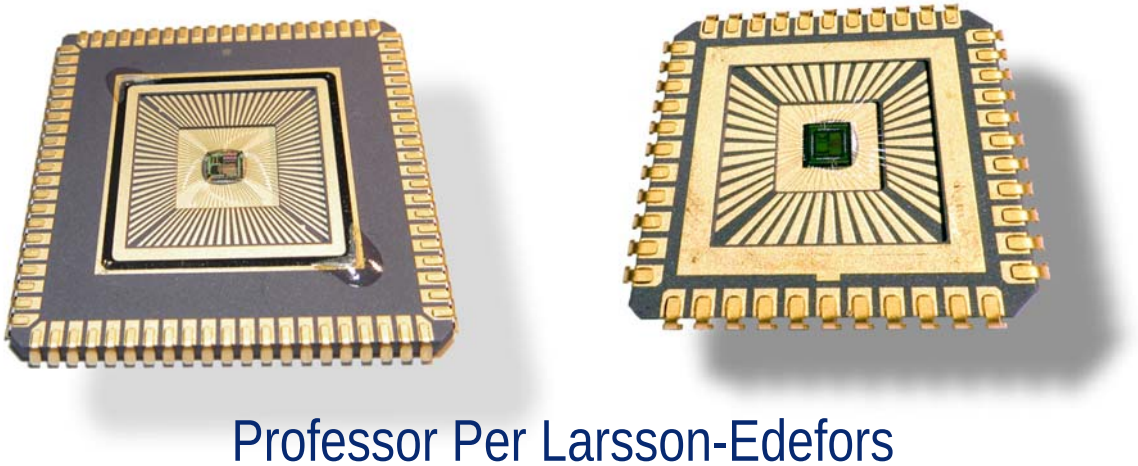
Elektroniksystem



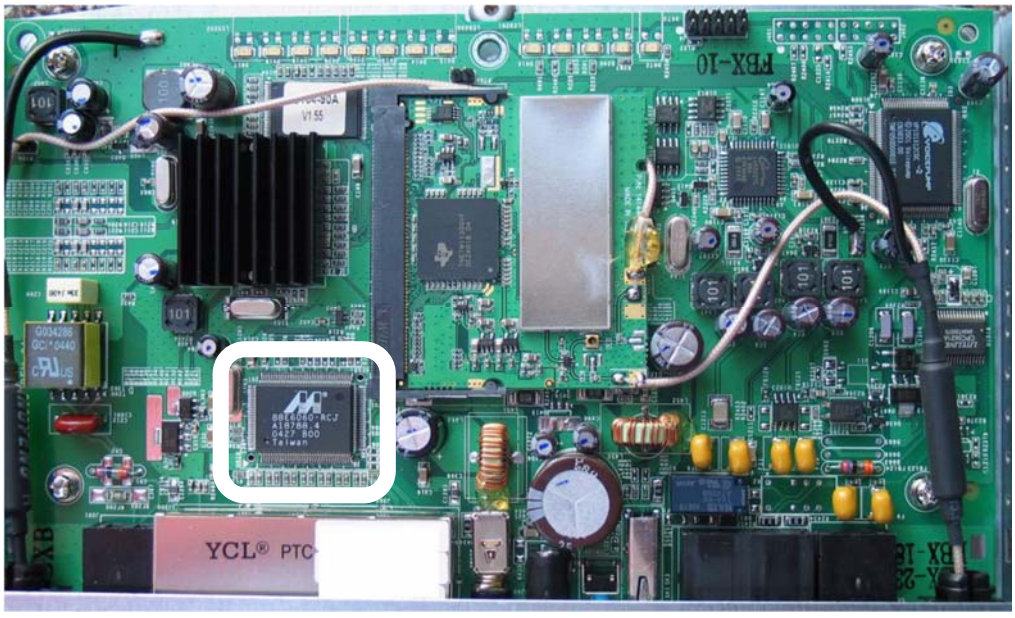
Professor Per Larsson-Edefors

perla@chalmers.se

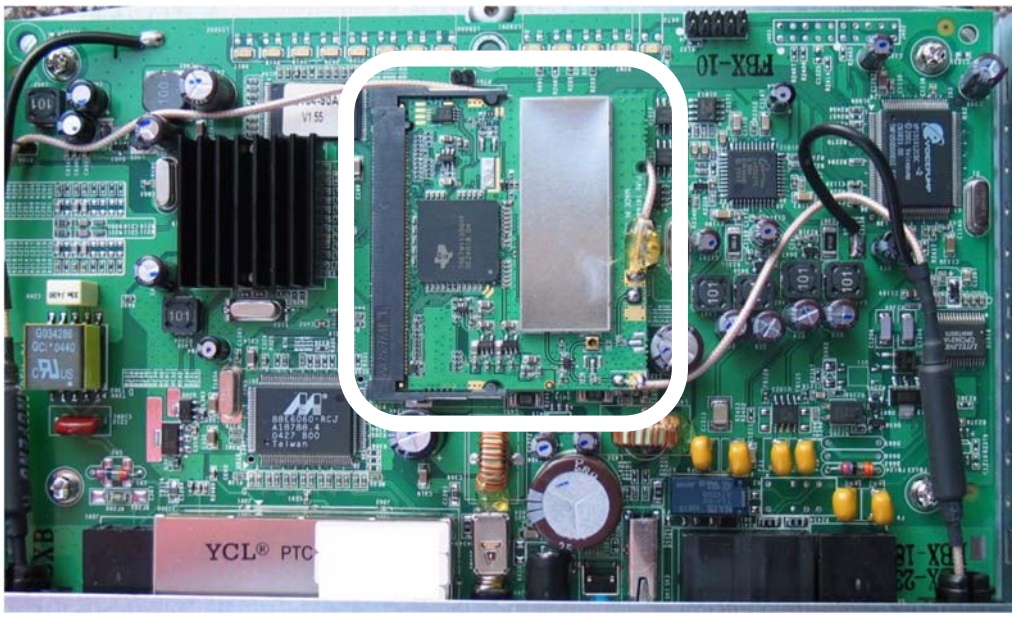
Kretskort med standardkomponenter

Innandömet av router

Ethernetswitch Marvell

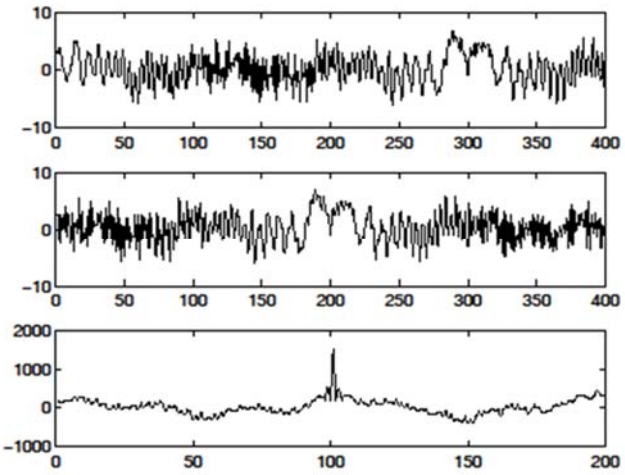


Basbandsprocessor TI



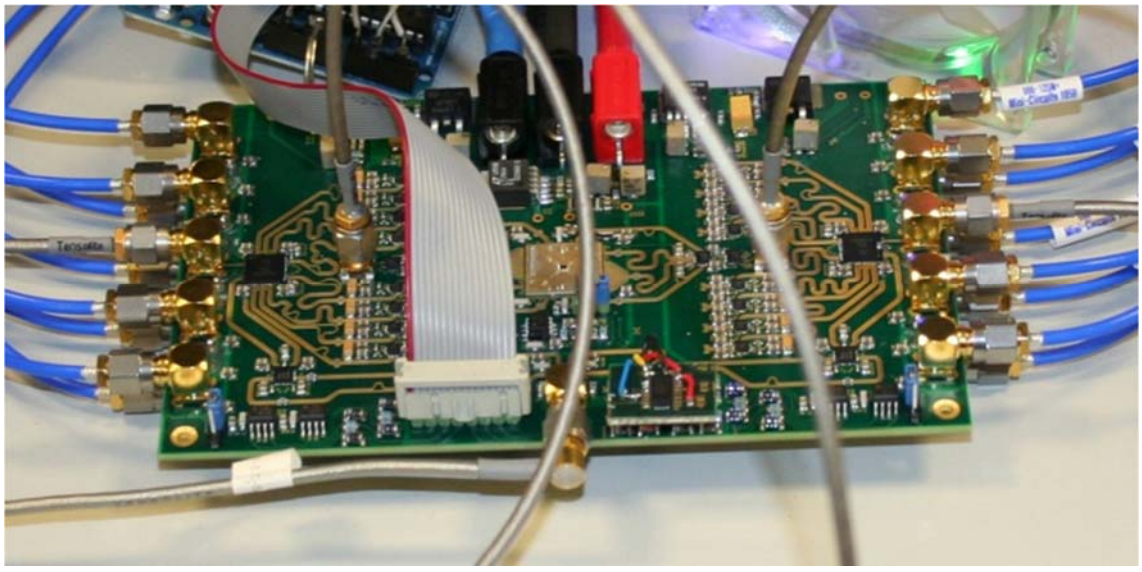
Application-Specific Integrated Circuit (ASIC)

Specialiserad tillämpning: Korskorrelation

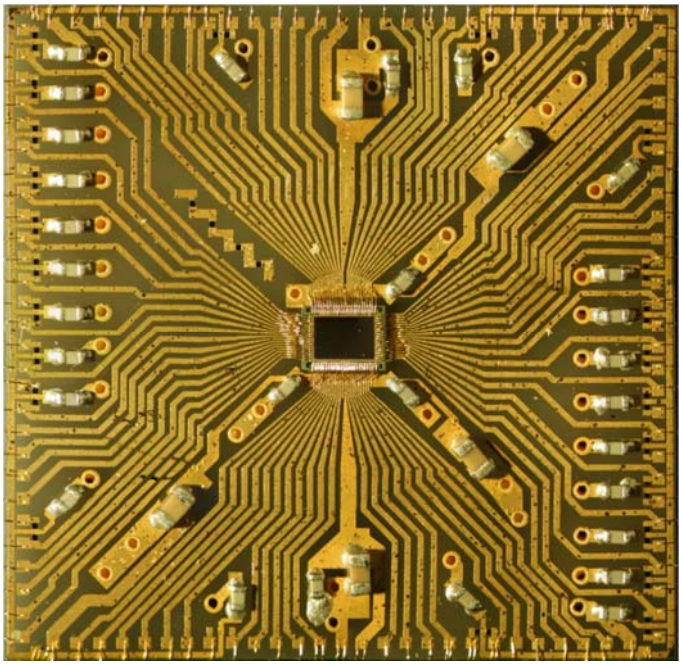


$$(f * g)[n] = \sum_{m=-\infty}^{\infty} f^*[m]g[n+m]$$

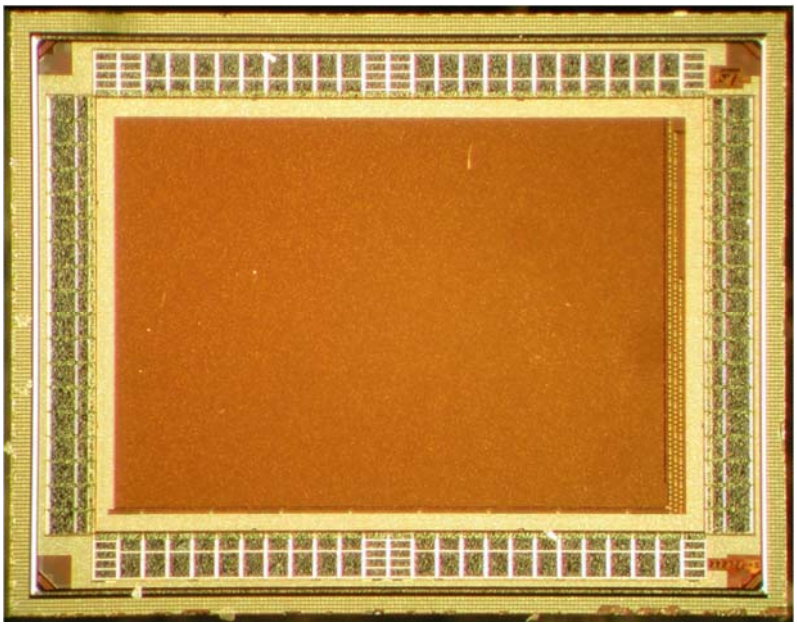
Specialgjort kretskort ...



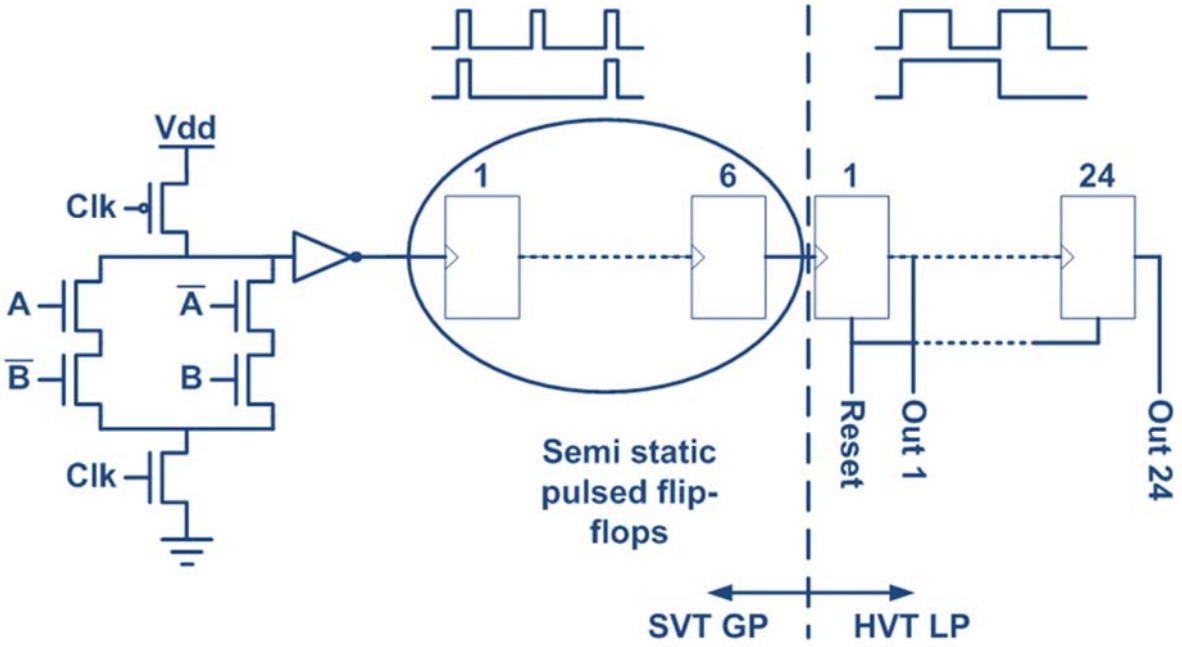
… med specialgjort substrat …



… med dedicerad IC …

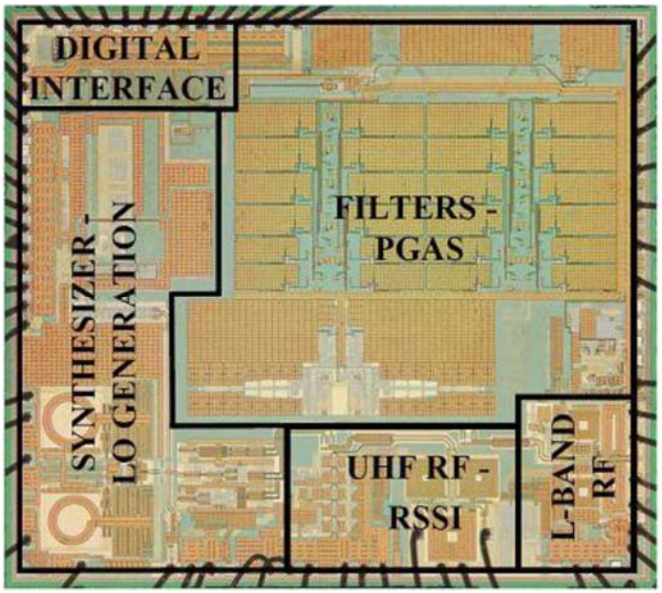


… med specialbyggda kretsar



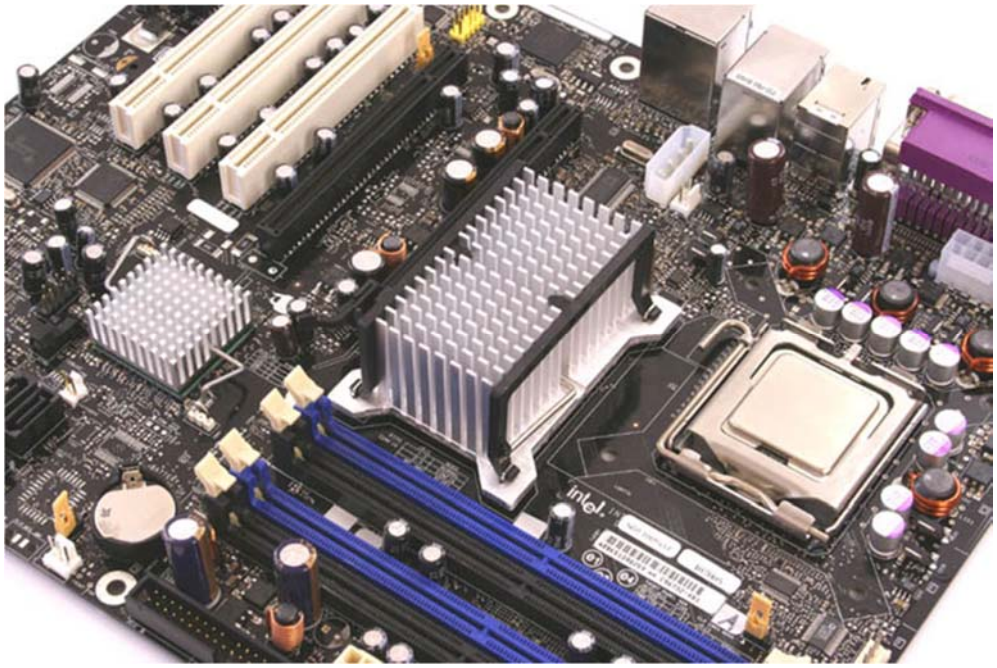
System-på-kisel (System-on-Chip - SoC)

Komplett DVB-mottagare

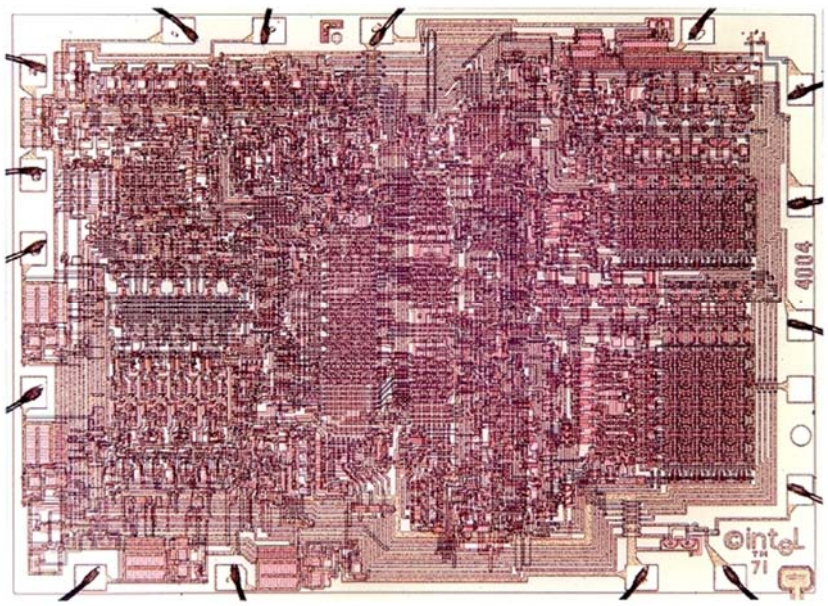


Processorbaserade system

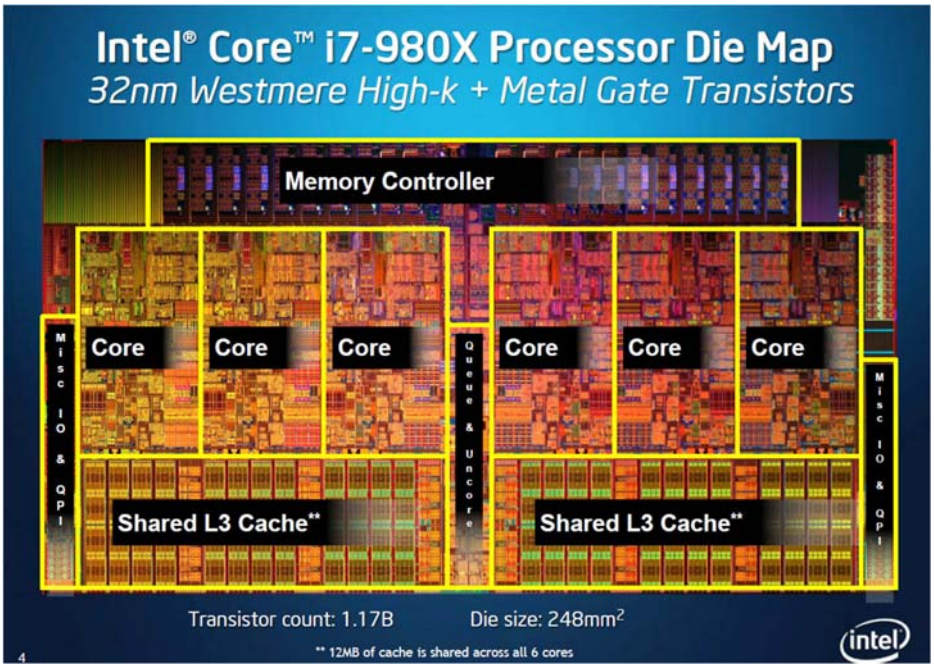
Moderkort med processor



Intel 4004 – 10 μm



Intel Core i7 980X – 32 nm



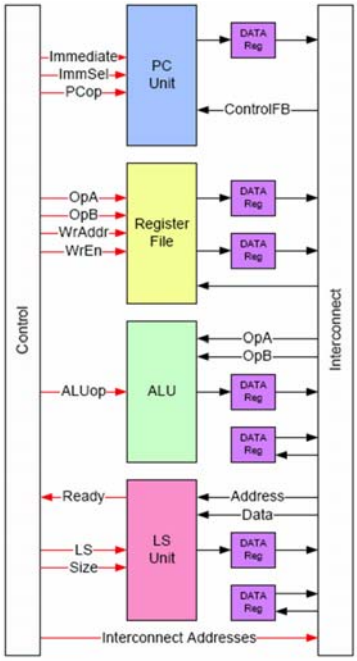
Source: Intel

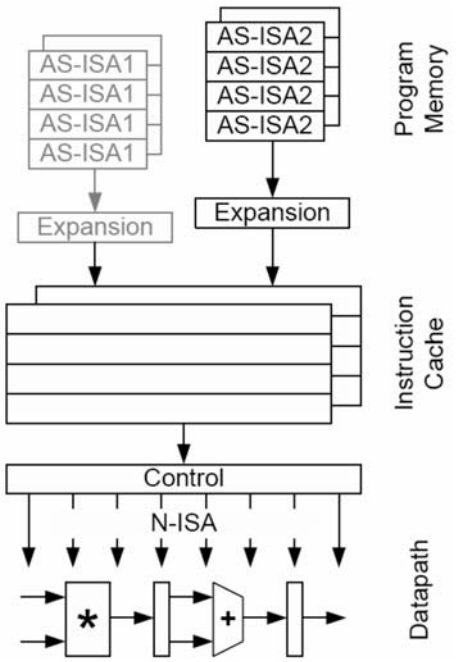
Bara mjukvara? Mjuk FPGA uP

Time Taken (%)	Function Name	Total Time (seconds)	Self Time (seconds)	Number of Calls
30.21	MAD_F_MUL_16	49.53	49.53	41731200
23.38	MAD_F_MUL_28	87.88	38.34	161335830
10.69	synth_full	105.40	17.52	1150
9.01	dct32	120.18	14.78	82800
3.96	imdct36	126.68	6.50	100665
3.47	III_huffdecode	132.37	5.70	4600
1.66	XSysAce_RegRead32	135.10	2.73	
1.47	III_requantize	137.50	2.40	142413
1.30	III_imdct_l	139.63	2.12	100665
1.10	XSysAce_ReadDataBuffer	141.43	1.81	
1.05	III_sideinfo	143.15	1.71	1150
1.04	MadFixedToUshort	144.86	1.71	2649600
1.00	mad_bit_read	146.50	1.64	489234
0.93	III_overlap	148.04	1.53	105199
0.93	III_stereo	149.55	1.52	2300
0.91	XIo_EndianSwap16	151.05	1.50	
0.91	mad_frame_decode	152.54	1.49	1528
0.81	MicroBlaze_MP3Decode	153.86	1.32	1
0.74	XSysAce_RegRead16	155.08	1.22	
0.73	III_aliasreduce	156.28	1.20	4398
0.62	play_sound	157.29	1.01	2649600
0.42	III_decode	157.98	0.69	1150
0.38	XSysAce_WriteSector	158.61	0.63	
0.35	III_overlap_z	159.18	0.57	42001
0.34	mad_stream_init	159.73	0.55	1
0.29	mad_layer_III	160.21	0.48	1150
0.28	init_sound	160.67	0.46	1
0.28	XIo_EndianSwap32	161.12	0.45	
0.23	memcpy	161.50	0.38	
0.20	III_freqinver	161.83	0.33	73600
0.18	XUartLite_SendByte	162.13	0.30	

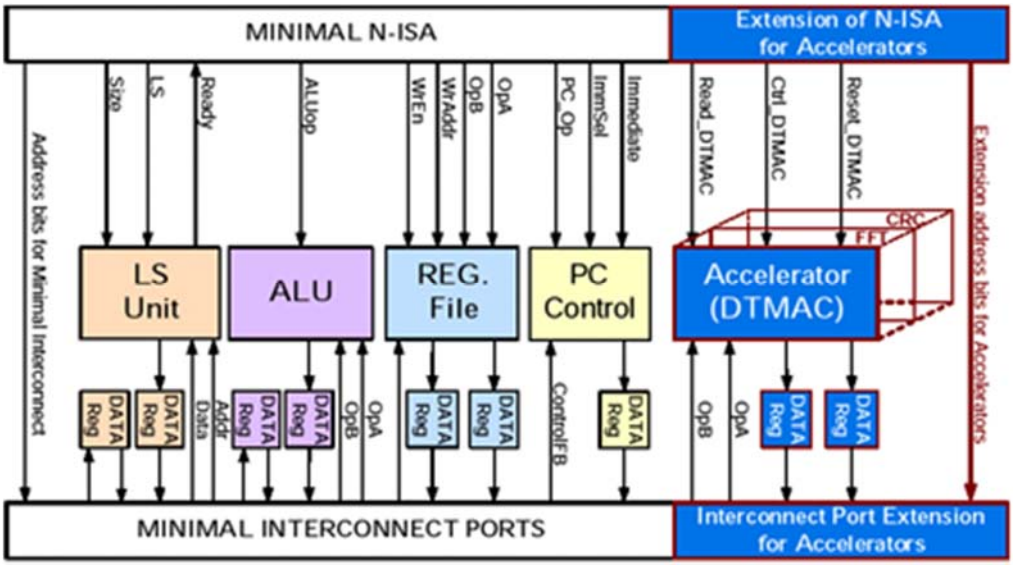
Source: Xilinx

FlexCore (Chalmers)

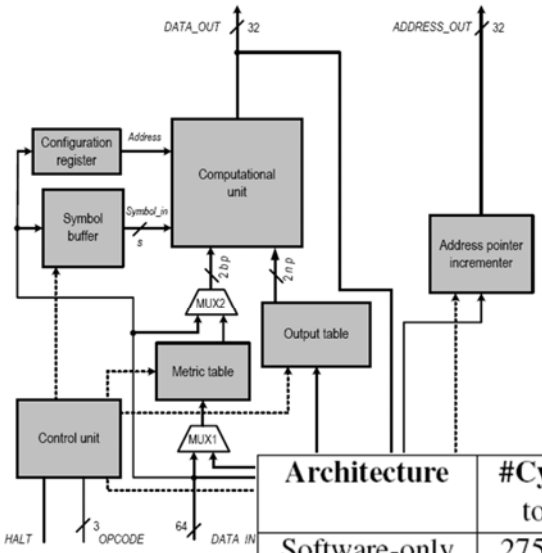




Utbyggbar processor – HW/SW codesign



FEC Acceleration



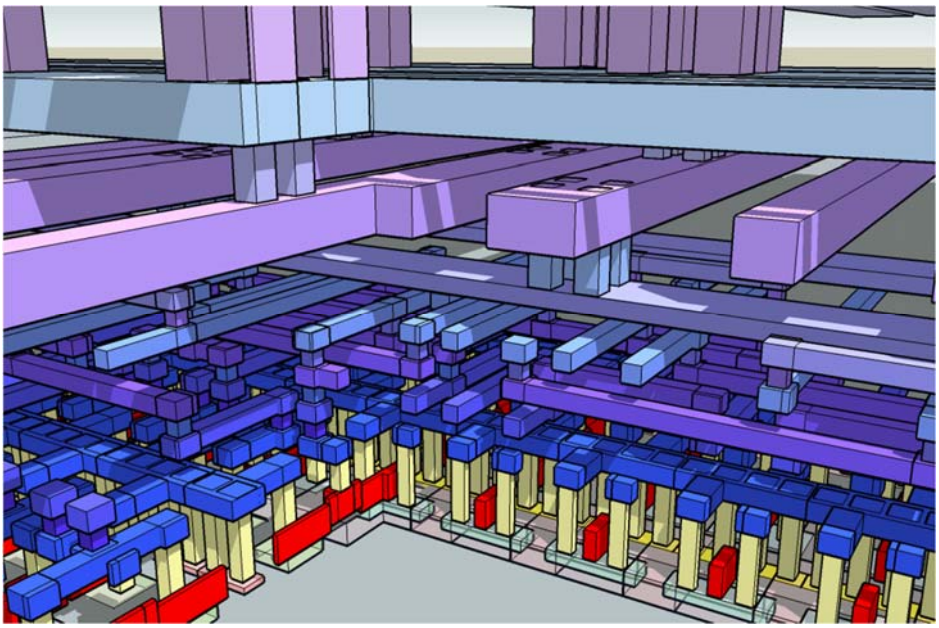
Architecture	#Cycles total	#Cycles kernel	Area (μm^2)	Power (mW)	Energy (μJ)
Software-only	275,076	251,575	53,737	8.97	6.67
Accelerated	26,614	3,113	64,209	12.4	0.89

Jämförelse

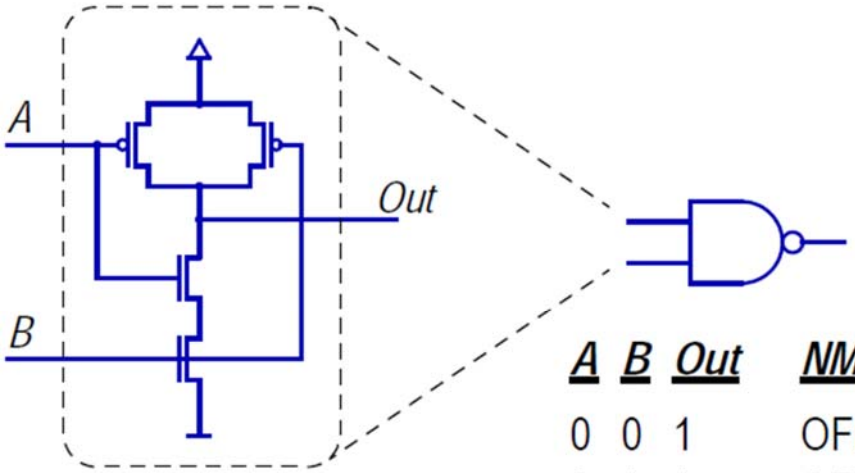
- Kretskort med standardkretsar VS SoC.
  - Utvecklingskostnad / kompetenskrav.
  - Prestanda och formfaktor.
  - Unit cost / seriestorlek.
  - Integration.
- ASIC VS processor.
  - Prestanda.
  - Flexibilitet.
  - Analogt/digitalt.
  - ASIPs.

IC-teknologi

Den integrerade kretsen

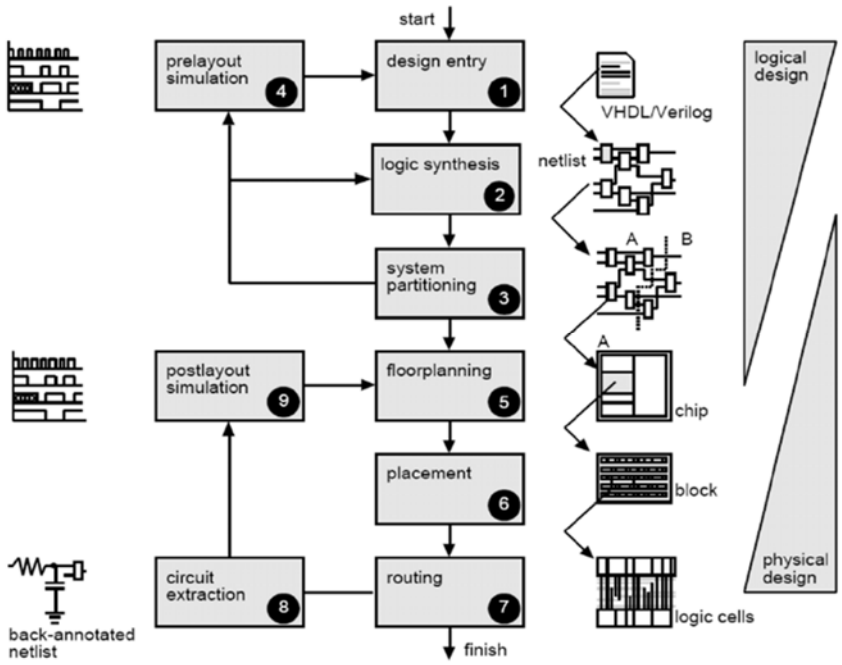


Grind och transistorer

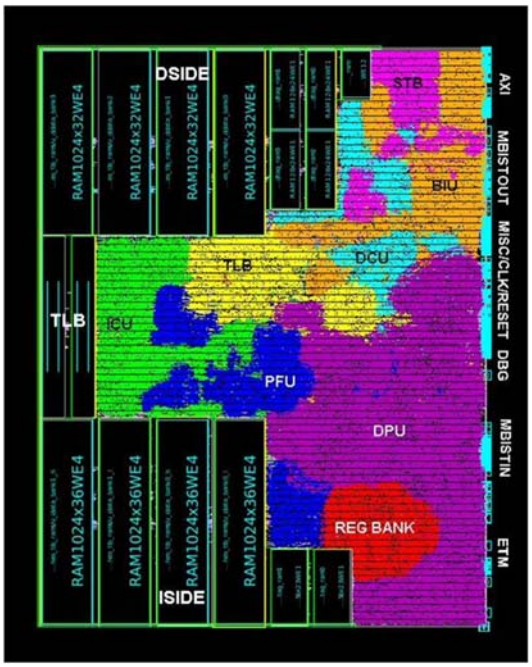


A	B	Out	NMOS	PMOS
0	0	1	OFF	ON
0	1	1	OFF	ON
1	0	1	OFF	ON
1	1	0	ON	OFF

Konstruktionsflöde

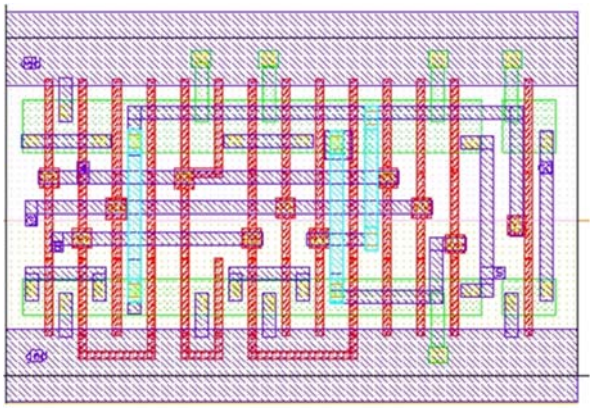


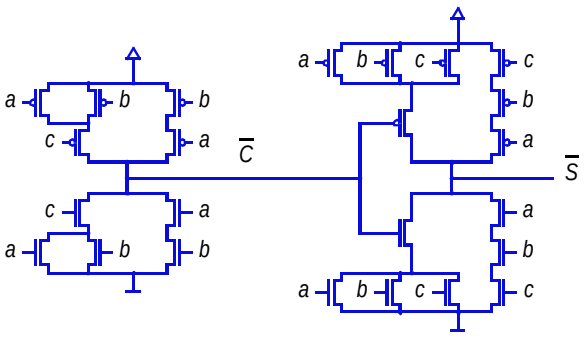
Cellbaserad ASIC



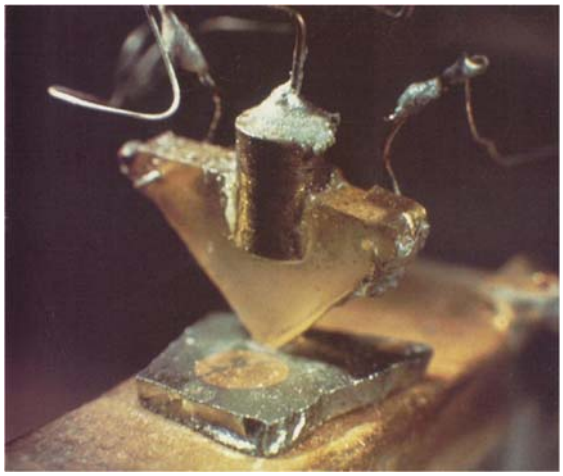
Source: ARM

En heladderare

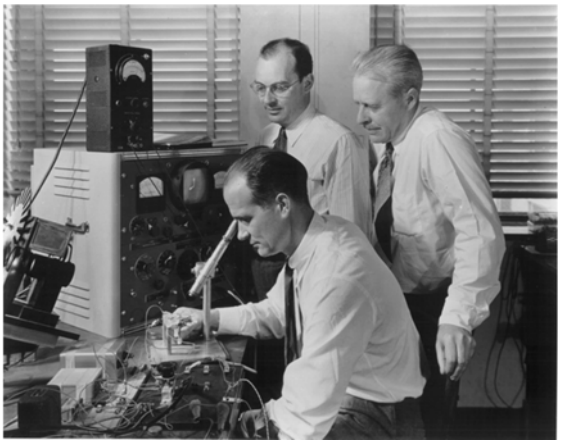




Ursprunget: Dec 16, 1947

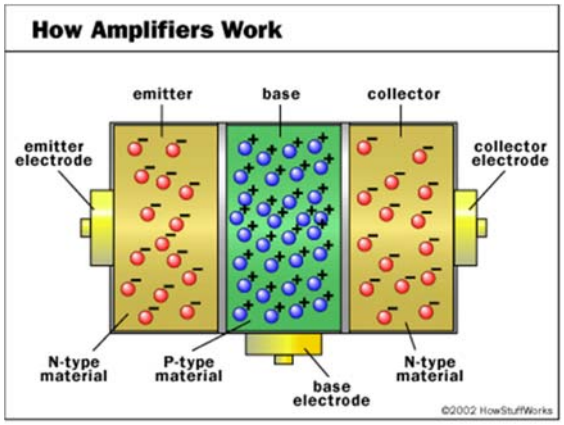


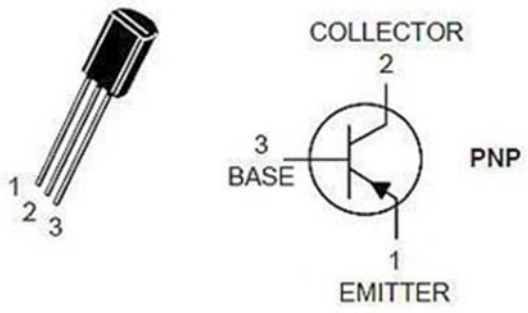
Source: TaylorEdge



Source: Wired.com

Bipolärtransistorn





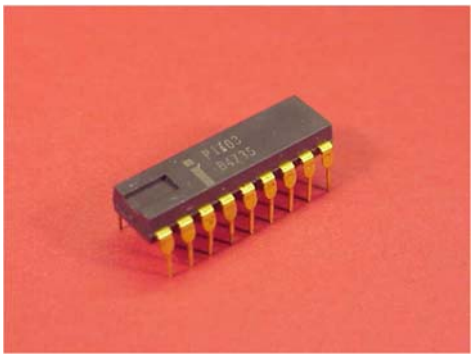
Source: How-stuff-works

Fasta tillståndets fysik

- Integrationsansträngningar post Sputnik & transistorradios:
  - 1958: Hoerni - planarprocessen (Si/SiO_2).
  - 1959: Noyce - integrated circuits.
  - 1960: Si MOSFET (Kahng och Atalla @ Bell).
  - 1966: 1-T DRAM cell (Dennard @ IBM).
- Så småningom slår MOSFET/fälteffekt ut bipolärtransistorn.

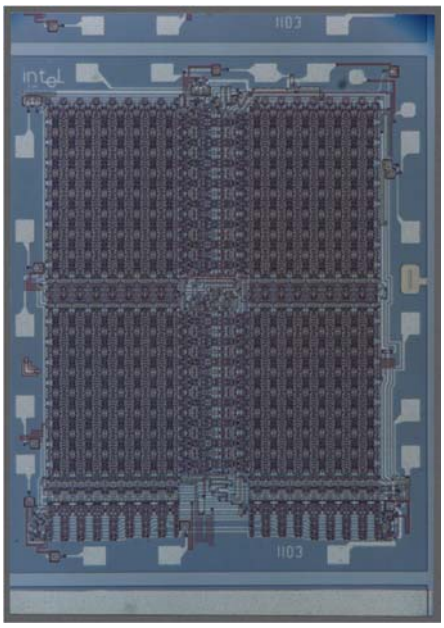
Genombrott: MOSFET-minnen

- 1970: Intel 1103, första DRAMet (1 kbit, PMOS-baserat).
- 1972: 1103 storsäljare.

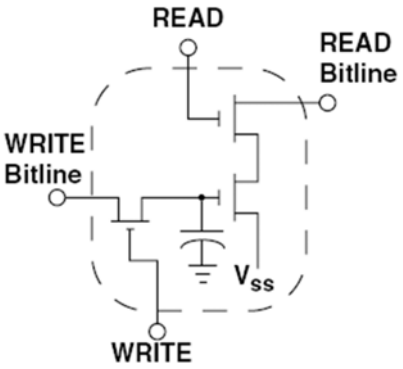


Source: Intel

Intel 1103

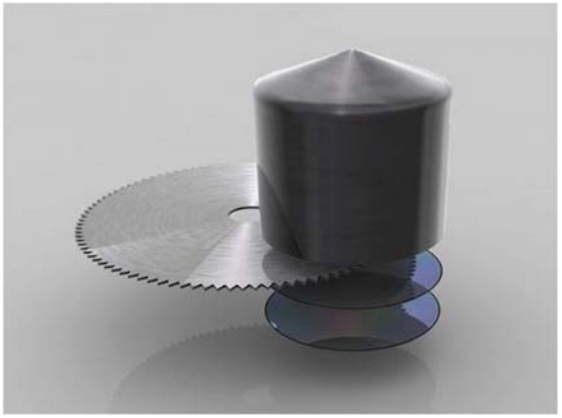


Source: Intel

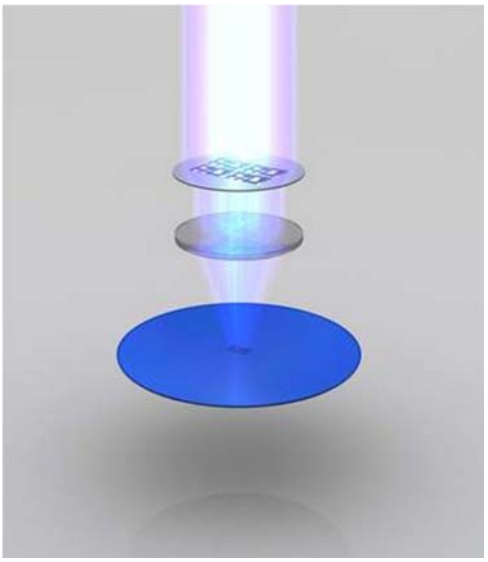


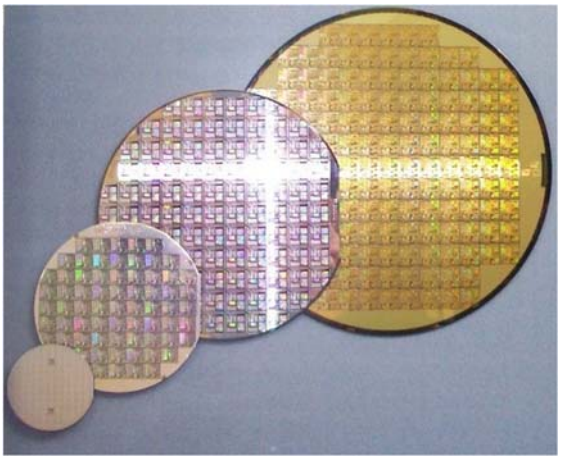
Source: *Memory Systems*, Elsevier

Tillverkning av wafers

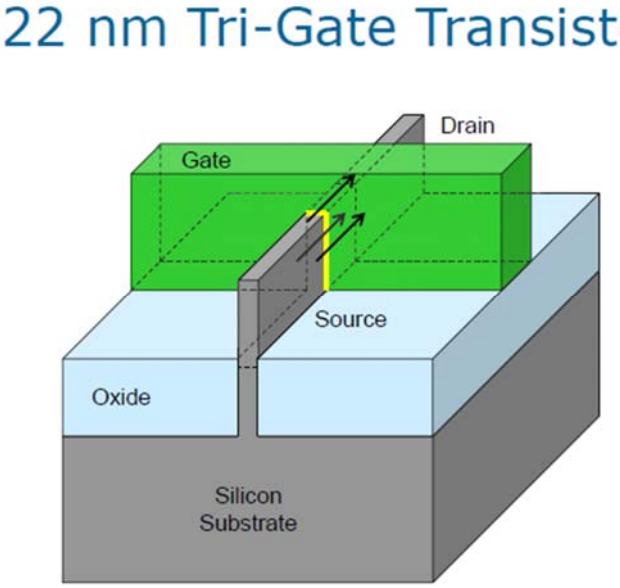


Kostnadseffektiv litografi; hur?





Ny transistortyp krävs



Sammanfattning

- Olika plattformar.
  - ASIC, FPGA, standardkomponenter; nyheter på gång!
- Olika konstruktionsmetoder.
  - Manuell vs CAD. Mjukvara vs hårdvara.
    Analogt vs digitalt
- Komplexa system och komplex teknologi
  krävs för hög funktionalitet, hög prestanda,
  och effektiv implementation.
  Se till att skaffa er nyckelkompetenserna!