

Willkommen
Welcome
Bienvenue

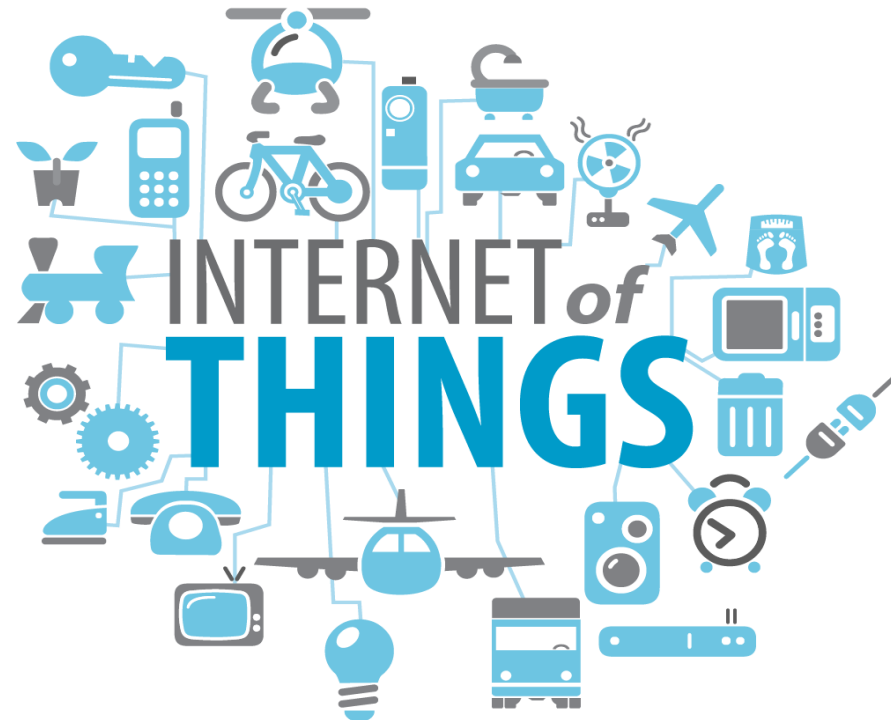


Empa

Materials Science and Technology

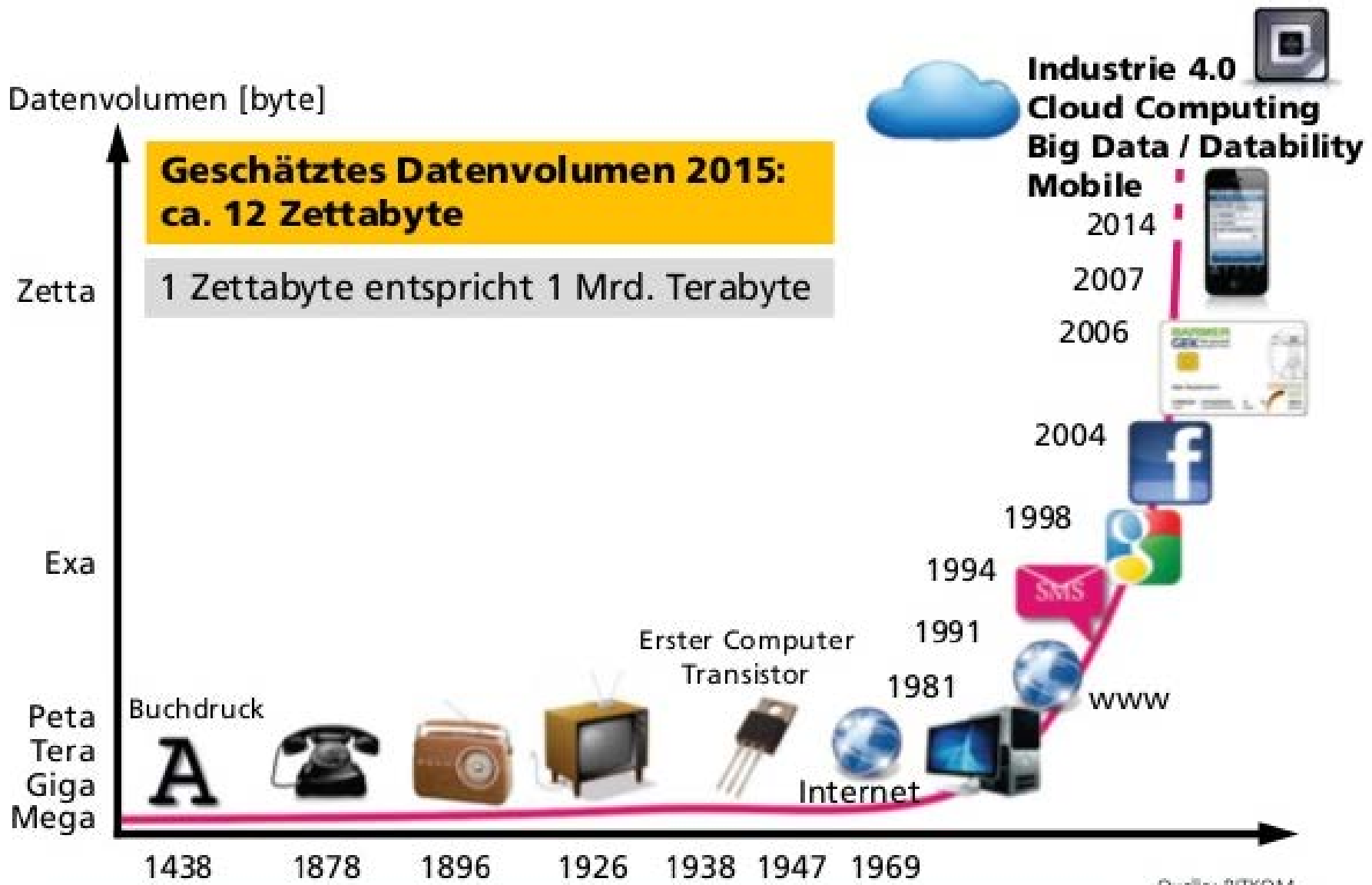
Mit neuen Materialien zum Internet of Things – mit Mut zu neuen Produktionsmethoden

Gian-Luca Bona



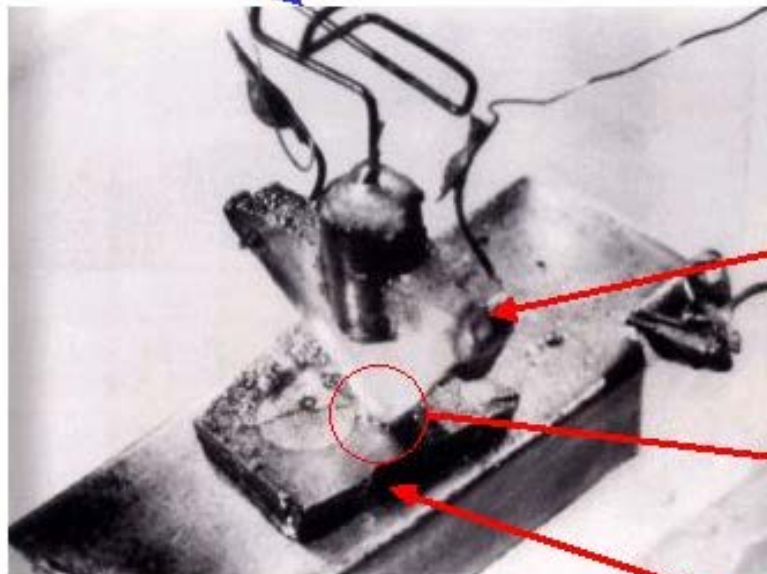
<https://ict.swisscom.ch/2015/01/themenmonat-auf-dem-ict-blog-der-januar-im-zeichen-von-internet-of-things/>

Daten vernetzen die Welt



Erster Transistor

Andruckfeder



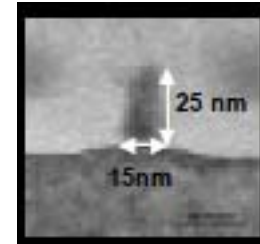
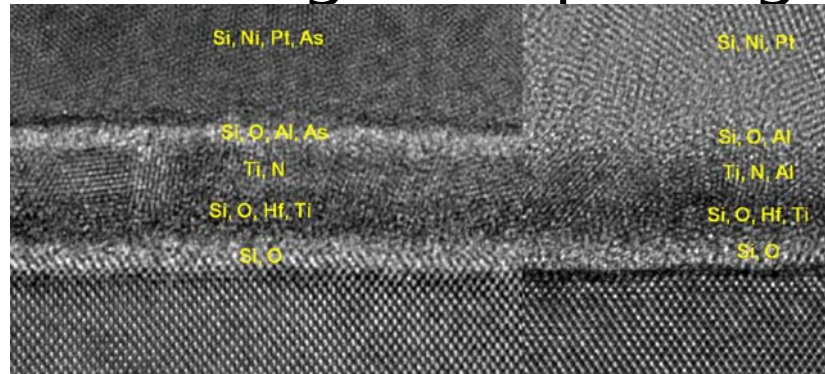
Plastikdreieck mit
Goldfolienkontakten

Punktkontakttransistor

Germanium

Brattain, Bardeen (1947)

Materialforschung & Chip-Integration



Before 90's
Since the 90's
Beyond 2006

hydrogen 1 H																	helium 2 He						
lithium 3 Li 6.941	beryllium 4 Be 9.0122																	boron 5 B	carbon 6 C	nitrogen 7 N	oxygen 8 O	fluorine 9 F	neon 10 Ne 20.180
sodium 11 Na 22.990	magnesium 12 Mg																	aluminum 13 Al	silicon 14 Si	phosphorus 15 P	sulfur 16 S 32.065	chlorine 17 Cl	argon 18 Ar 39.948
potassium 19 K 39.098	calcium 20 Ca	scandium 21 Sc	titanium 22 Ti	vanadium 23 V	chromium 24 Cr	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co	nickel 28 Ni	copper 29 Cu	zinc 30 Zn	gallium 31 Ga 69.723	germanium 32 Ge	arsenic 33 As	selenium 34 Se 78.96	bromine 35 Br	krypton 36 Kr 83.80						
rubidium 37 Rb 85.468	strontium 38 Sr	yttrium 39 Y	zirconium 40 Zr	niobium 41 Nb	molybdenum 42 Mo	technetium 43 Tc [98]	ruthenium 44 Ru	rhodium 45 Rh	palladium 46 Pd	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb	tellurium 52 Te	iodine 53 I 126.90	xenon 54 Xe						
caesium 55 Cs 132.91	barium 56 Ba	57-70 *	lutetium 71 Lu 174.97	hafnium 72 Hf	tantalum 73 Ta	tungsten 74 W	rhenium 75 Re	osmium 76 Os 190.23	iridium 77 Ir	platinum 78 Pt	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]					
francium 87 Fr [223]	radium 88 Ra [226]	89-102 **	lanthanum 57 La [262]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [269]	meitnerium 109 Mt [268]	unnilium 110 Uun [271]	ununium 111 Uuu [272]	unbinium 112 Uub [277]											

*lanthanoids

lanthanum 57 La	cerium 58 Ce	Praseodymium 59 Pr	neodymium 60 Nd	promethium 61 Pm [145]	samarium 62 Sm	europium 63 Eu	gadolinium 64 Gd	terbium 65 Tb	dysprosium 66 Dy	holmium 67 Ho	erbium 68 Er	thulium 69 Tm	ytterbium 70 Yb
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**actinoids

actinium 89	thorium 90	protactinium 91	uranium 92	neptunium 93 [237]	plutonium 94 [244]	americium 95 [243]	curium 96 [247]	berkelium 97 [247]	californium 98 [251]	einsteinium 99 [252]	fermium 100 [257]	mendelevium 101 [258]	nobelium 102 [259]
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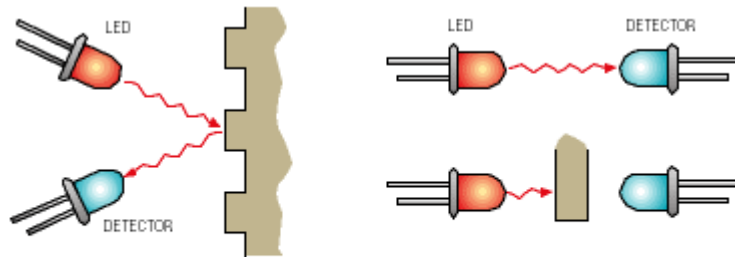
... und hochintegriert

Node (nm)	Min. W (nm)	Transistors (cm ² /chip)	Year
45	70-80	0.4B / 1.8B	2008
32	50-60	0.8B / 3.6B	2010
22	35-45	~1.6B / 7.2B	2012
15	25-35	~3.2B / 14.4B	2014-15
11	16-25	~6.4 B / 25.8 B	2017-18
8	10-16	?	?
5	7-10	?	?

..... in Massen hergestellt

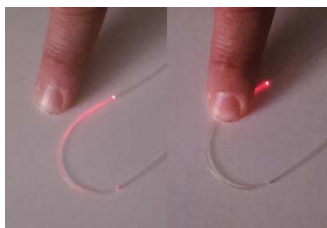


... und Sensoren

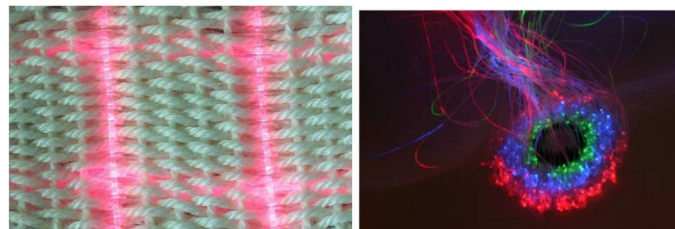


... für Netzwerke

... aber auch neue
Anwendungen



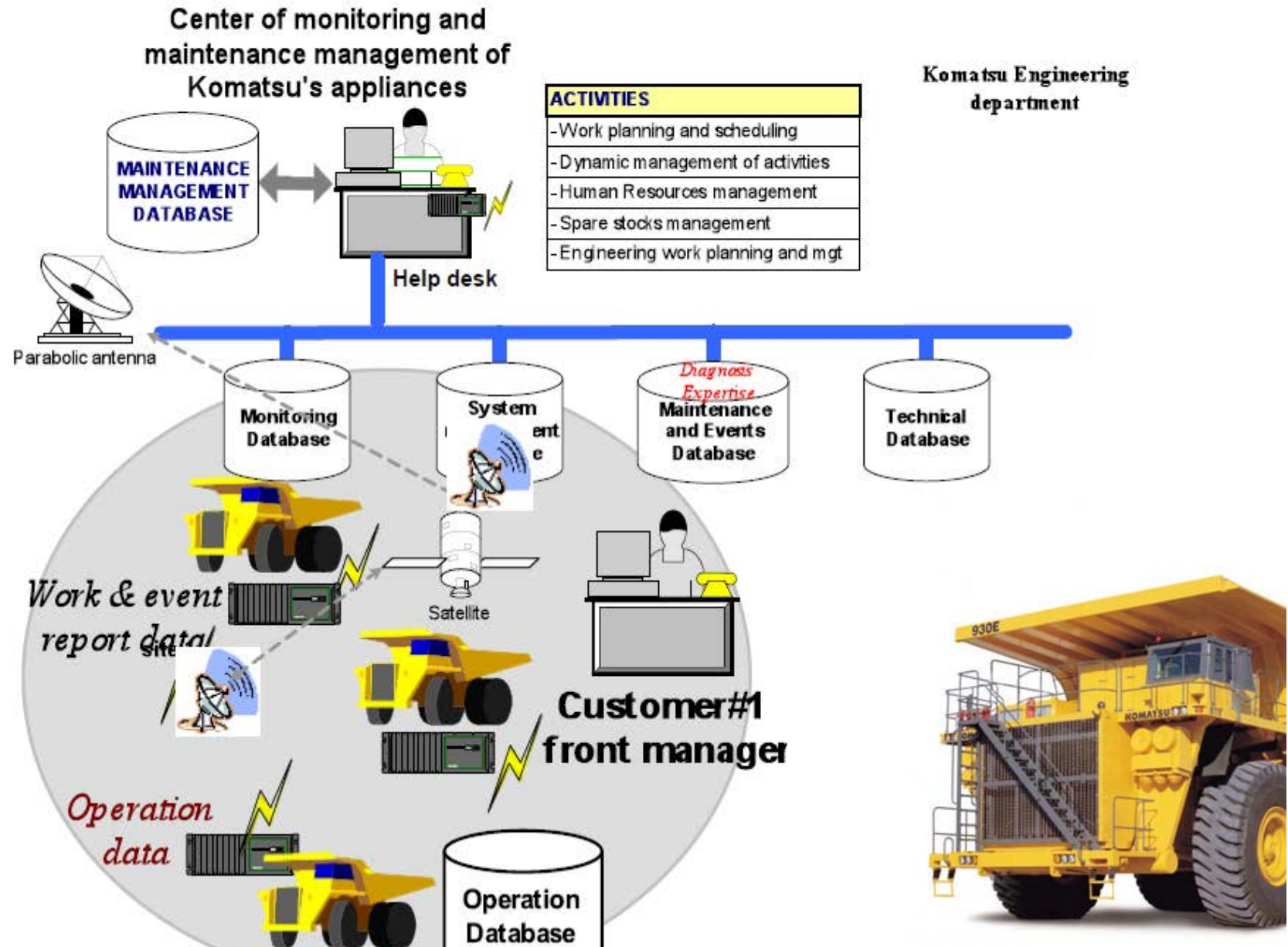
Flexible opt. Faser



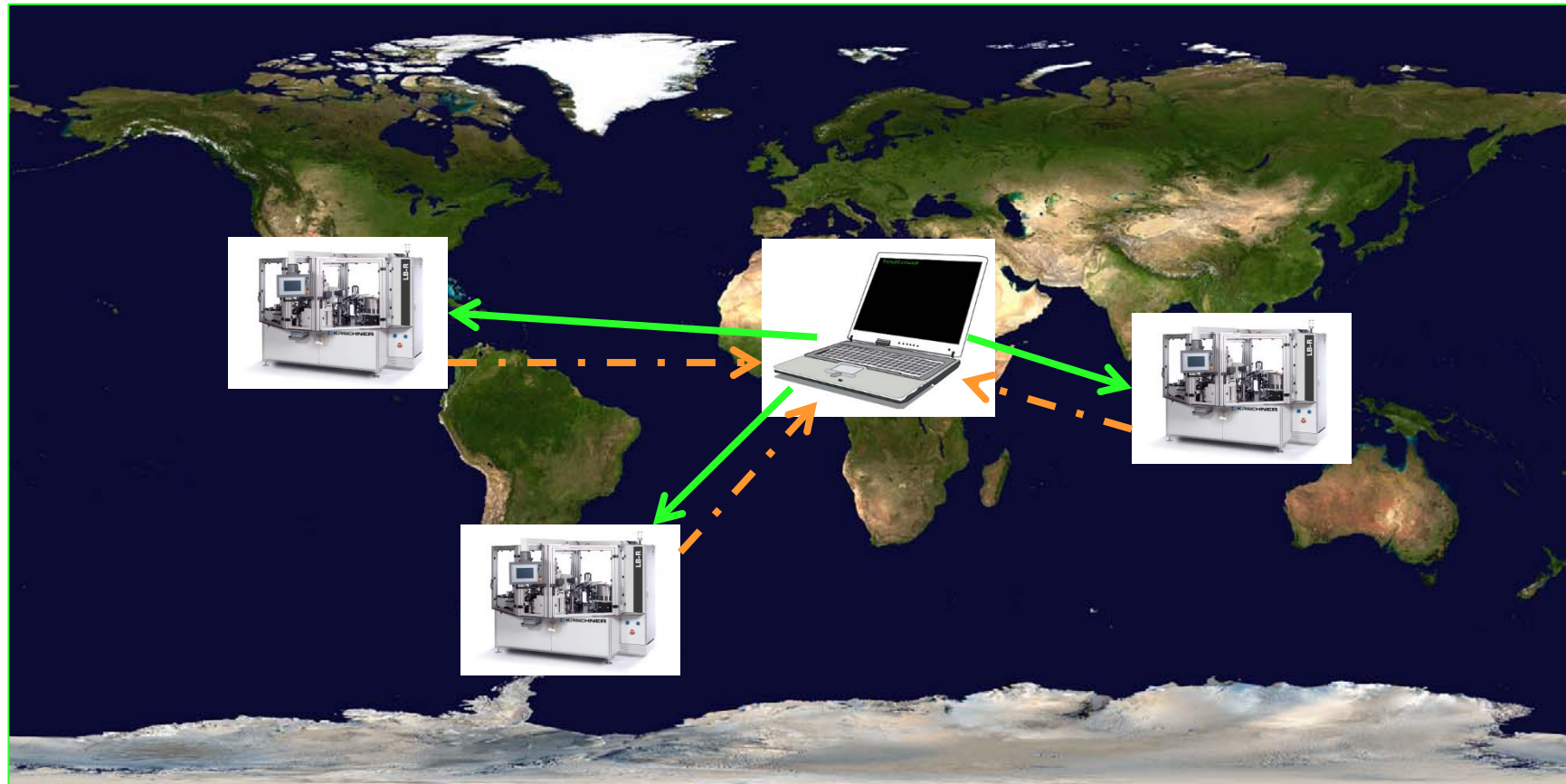
Textileintegration

.. in der Medizin

Komatsu's Remote Maintenance

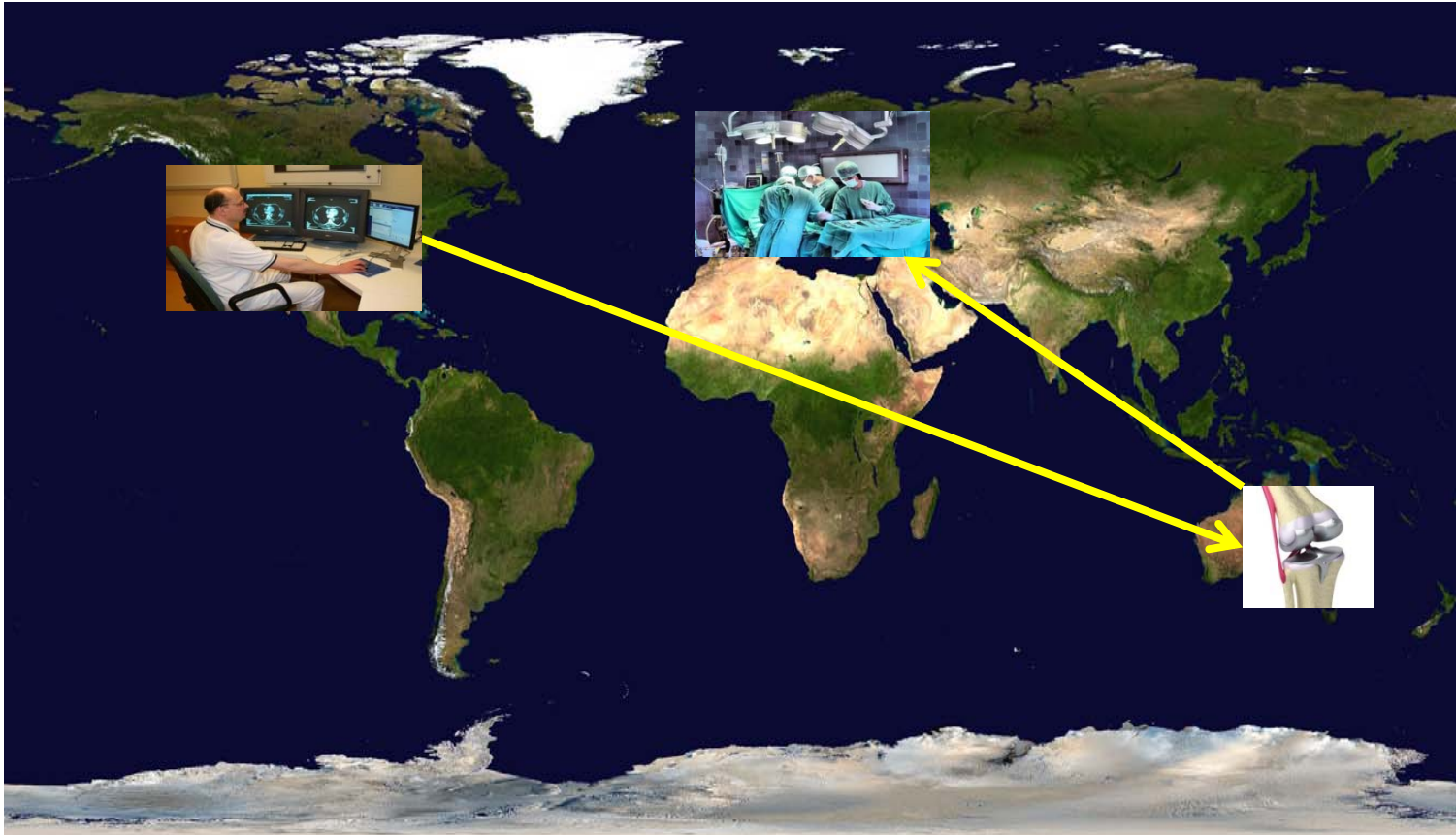


Vernetzte Produktion



- Produktion zentral steuern
- Fehler rascher erkennen und melden
- Prozesse optimieren

Individualisierte Produktion



- Auf individuelle Bedürfnisse angepasst
- Bestmögliche Qualität und Sicherheit

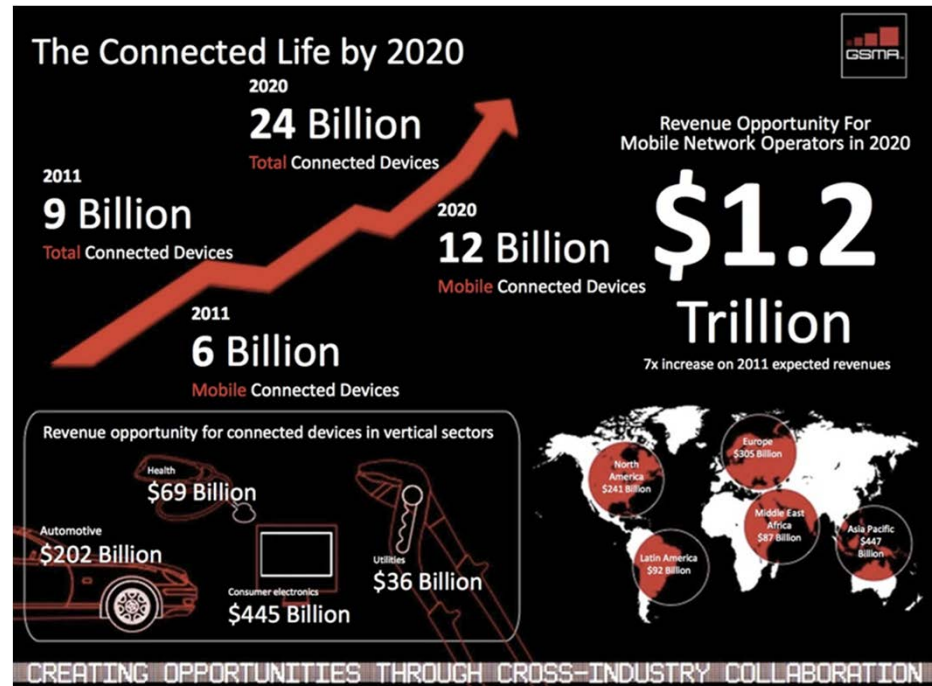
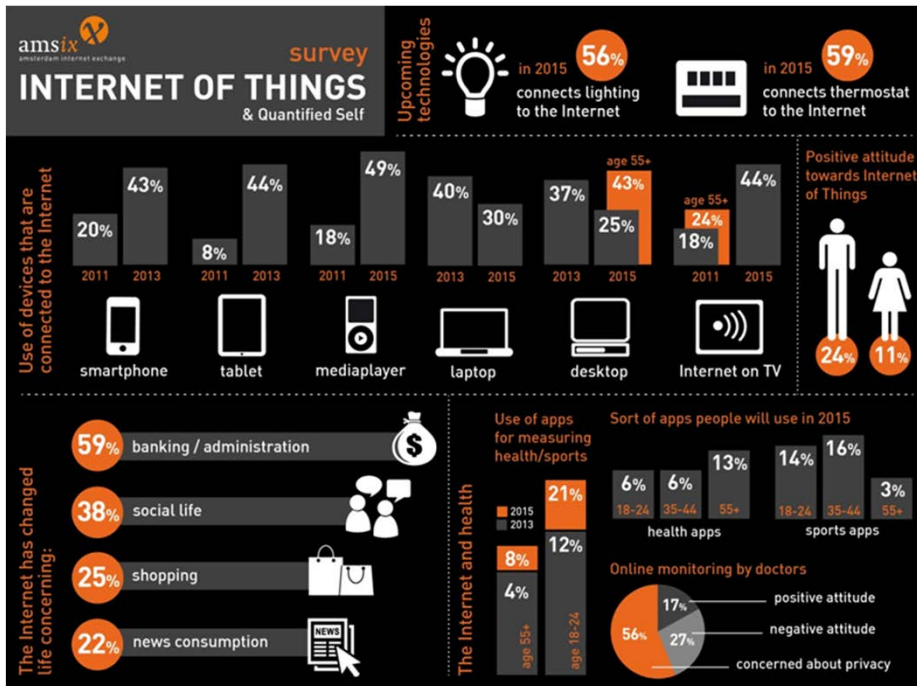
...aber nicht für alle

Year (July 1)	Internet Users	Users Growth	World Population	Population Growth	Penetration (% of Pop. with Internet)
2014*	2,925,249,355	7.9%	7,243,784,121	1.14%	40.4%
2013	2,712,239,573	8.0%	7,162,119,430	1.16%	37.9%
2012	2,511,615,523	10.5%	7,080,072,420	1.17%	35.5%

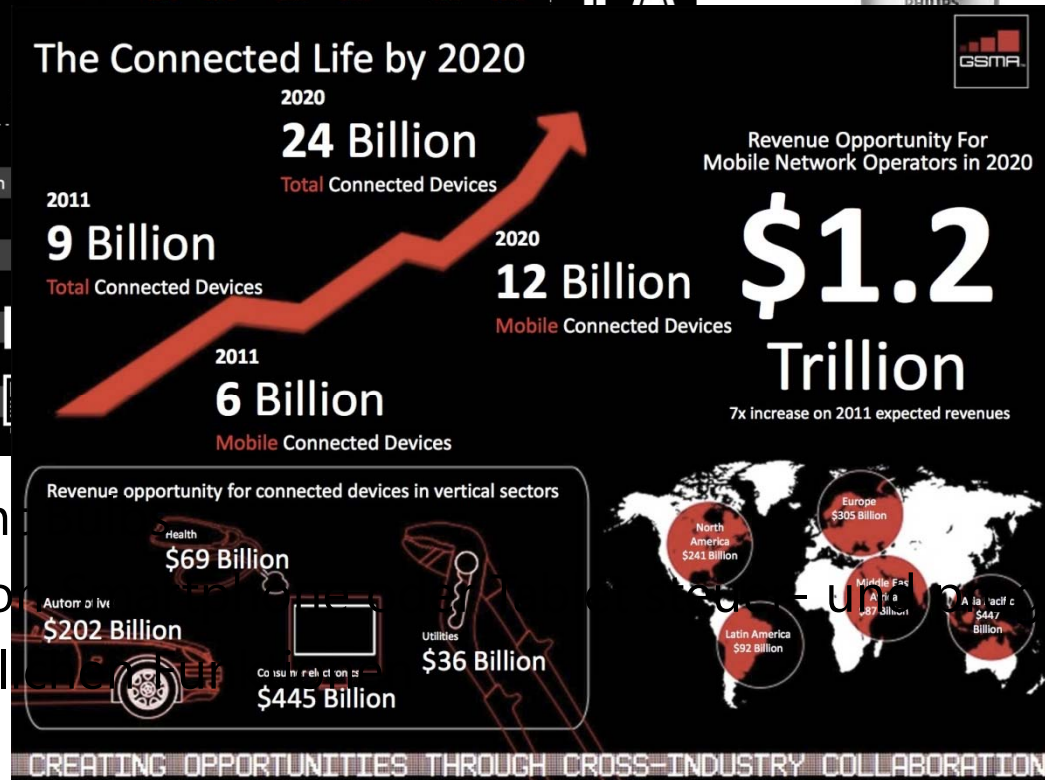
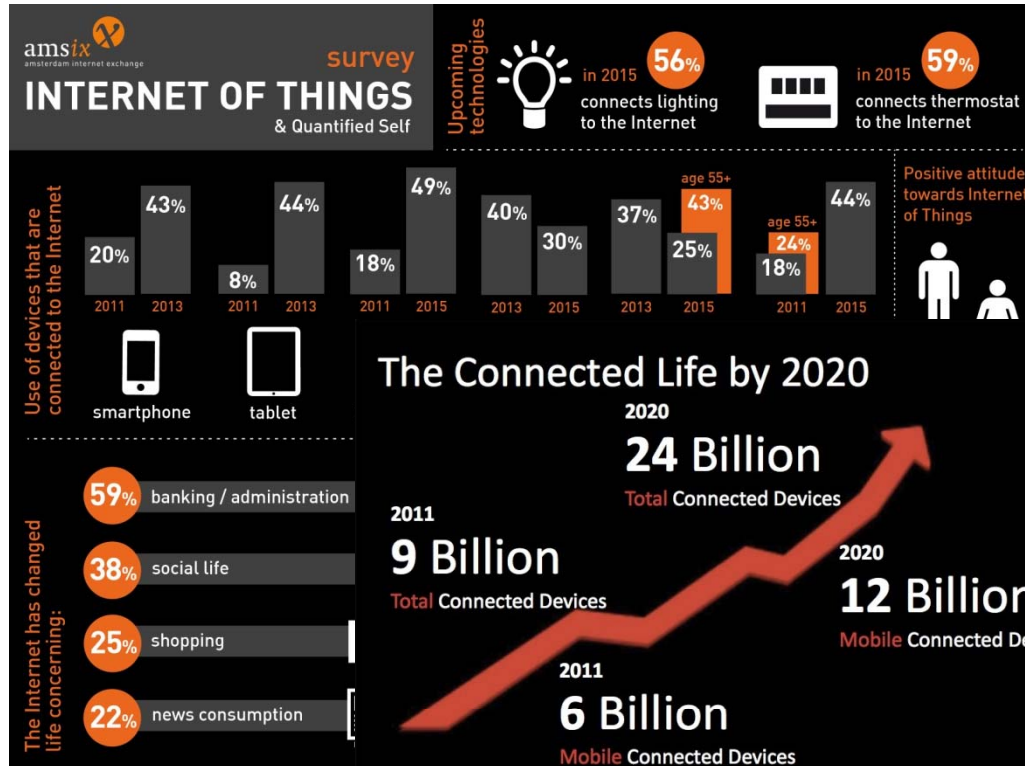
- Ohne Internet kein Internet of Things. Ohne Internet of Things keine Teilnahme an der globalen Wirtschaft und dem globalen Leben?

Zukunft ...

- Smart Light Bulbs
- Per App von Smartphone oder Tablet steuer- und programmierbar
- Mit zusätzlichen Funktionen



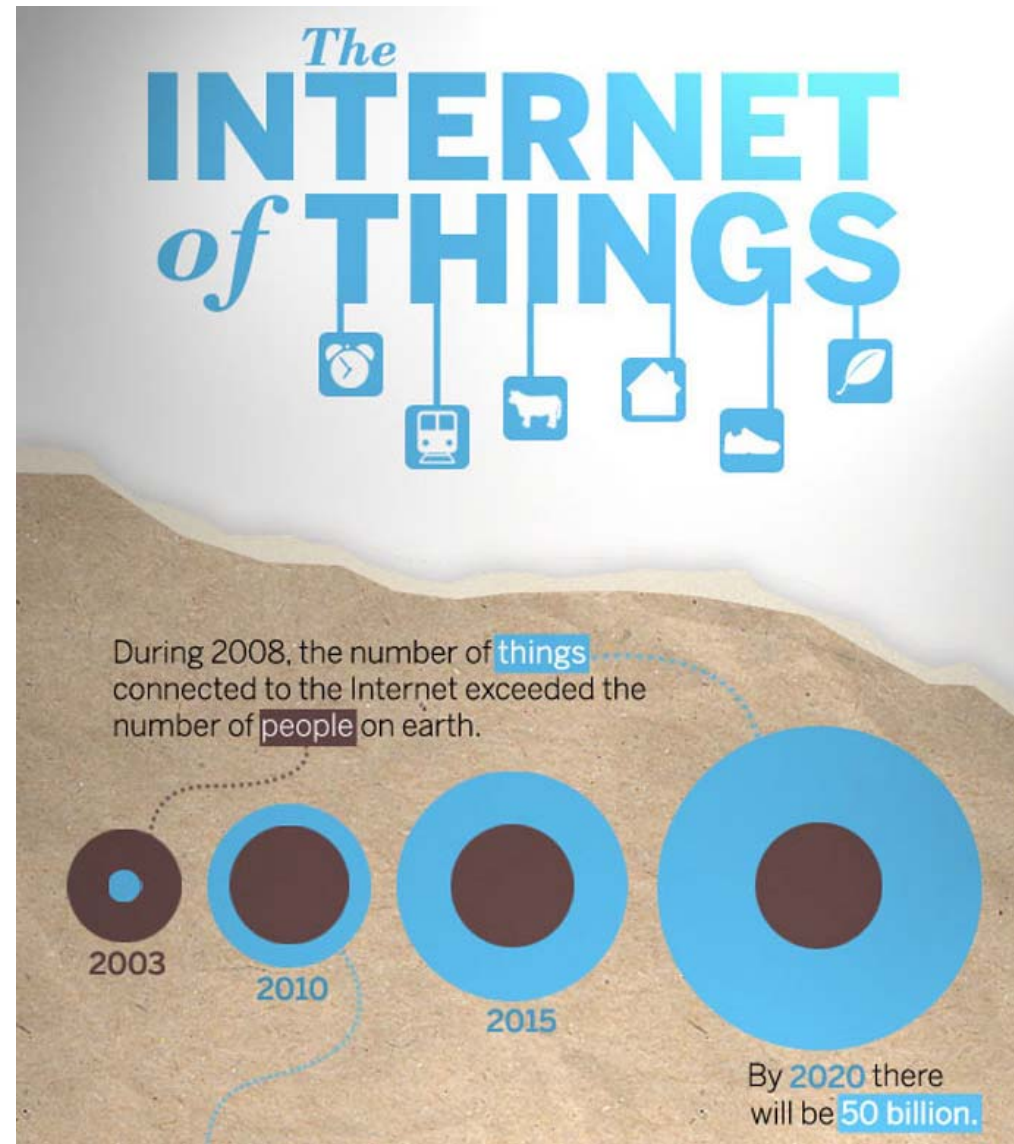
Zukunft ...



- Smart Light
- Per App vo
- Mit zusätzl

ammierbar

Zukunft ...



Veränderungen durch das Internet of Things



Industrial Automation



Smart Health



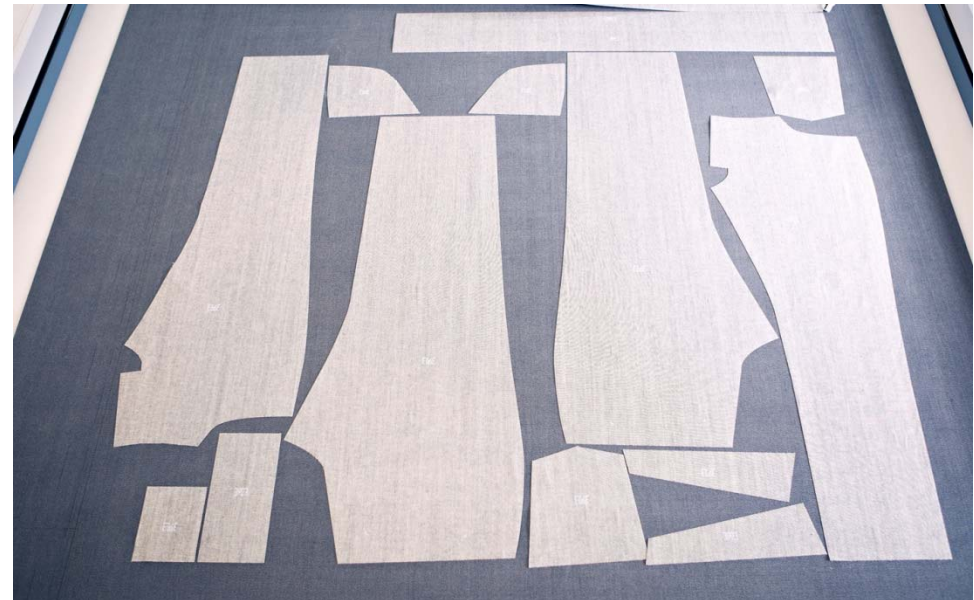
Smart Home



Smart City

Optimieren soll auch nachhaltig sein

- **Selfnation: massgeschneiderte Jeans zu gutem Preis** (ETH Spin-off)
 - Masseingabe zu Hause
 - Denimstoff aus Italien
 - Schneiderarbeit in der Schweiz und in Deutschland
-
- 'Kein' Lager
 - kürzere Transportwege
 - Kaum Überschussproduktion



SELFNATION

