Chip versus chipless for RFID applications

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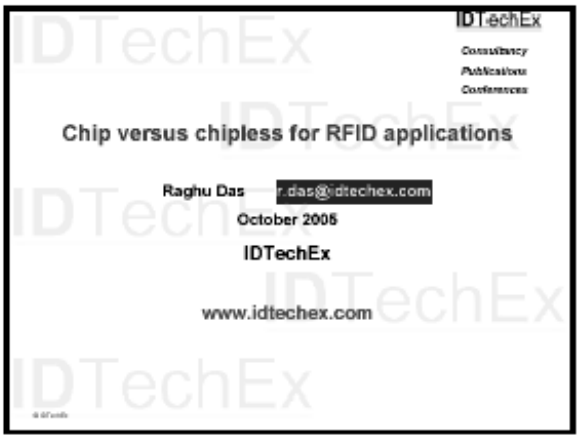

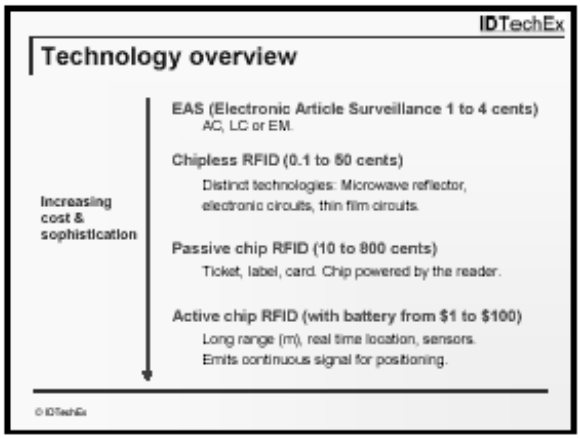

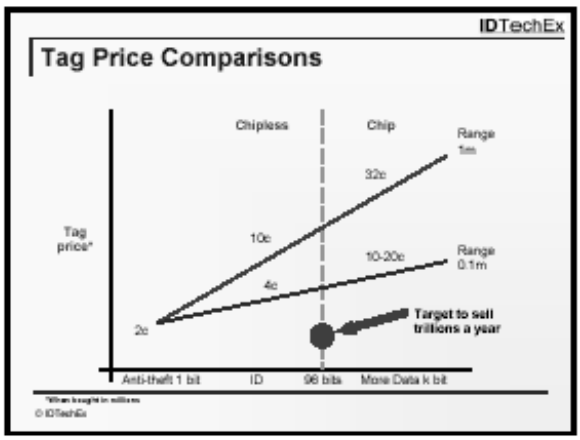

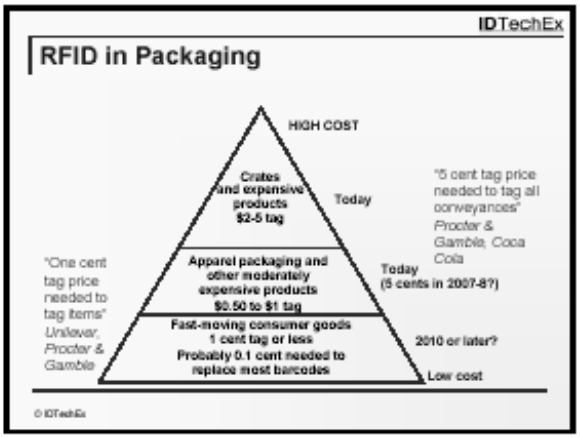

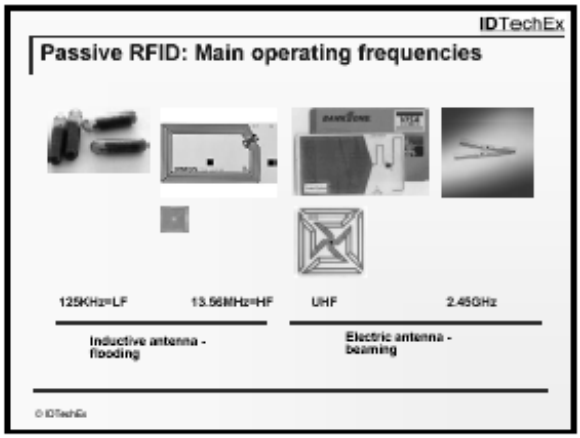

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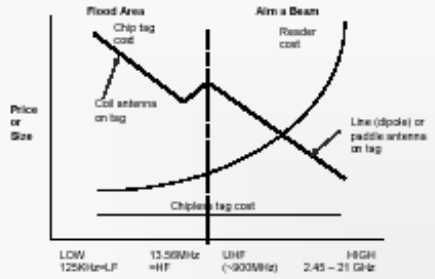
Frequency



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Achieving the 5 cent tag

RFID tag component	Tag Cost: MIT Auto ID Center/EPC global (cents)	Tag Cost: Rafsec (cents)	Auto ID Center, and Rafsec's 5 cent tag aim (cents)
Chip	20	24	1
Antenna	5	7*	1
Chip placement	5	5	1
Chip connection	5		
Conversion to package	Over 10*	5	1
Total	Over 45	41	< 5

* Includes substrate cost

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Chip Smart Labels

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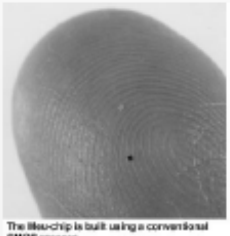
Ultra-small Chips are Very Important

e.g. eventually 0.1mm across, 20µm thick

- No supply famines?
- No brittleness problems
- Can go in paper etc.
- Thin chips double as pressure sensors
- Very low cost



The Hitachi-chip is built using a conventional CMOS process.

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CHOICE OF CHIP RFID SOPHISTICATION

HIGH COST	Encryption Radiolocation Read-write (write ~70% of read range EEPROM) Read only & read write Large memory Long range Well protected
LOW COST	Read only Small memory Short range Naked

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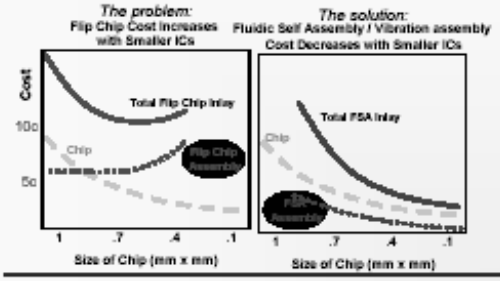
Scaling up Chip Bonding



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Chipless Smart Labels

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TWO GENERATIONS OF CHIPLESS RFID

FIRST GENERATION: Closed systems i.e. single service provider, no standards, usually little memory - anticounterfeiting, antitamper, secure access, product diversion, in house- track and trace, automated error prevention. Acoustomagnetic, electromagnetic, LC Array

SECOND GENERATION: Open systems i.e. multiple service provider, global standards e.g. EPC. Barcode replacement and more -
SAW and later polymer TFTCs and maybe thin film silicon TFTCs and maybe the secret VTT/Panipol printed pyridene label which has 96 bits read only but only at a few mm range.

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Digital Chipless Tags – potential benefits

Remote magnetics	Magnetostrictive	35 million sold
	Simple Electromagnetic	Radiation hard. Thinnest optics
	Barkhausen effect	70 million sold. Very secure
Transistorless circuits	Surface Acoustic Wave (SAW)	Millions sold. Meets standards. Radiation hard.
	Diode based	Suitable for insect tracking
	Coil-capacitor (LC)	Hundreds of thousands sold. Thin and robust
Transistor circuits	Polymer Electronics	Printable onto products. Meets standards
	Silicon film	High frequencies possible

VTT/ Panipol/ Mreal pyridene tag – secret technology — Printable onto products. 96 bits EPC

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Electromagnetic Chipless Technology

Confirm Technologies Israel

Link-Sure UK

Flying Null UK

MIT US

Example: Flying Null thread in a blister pack

- Range few centimetres (up to ~0.4m)
- World's thinnest and lowest cost tag

Flying Null can be used for machine readable

- Authentication
- Tamper Evidence
- Track and Trace

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Digital Chipless Tags – limitations

Remote magnetics	Magnetostrictive	Thick. Under 30 bits. Read only
	Simple Electromagnetic	Under 30 bits. Read only
	Barkhausen effect	Expensive. Read only. Few bits
Transistorless circuits	Surface Acoustic Wave	Thick. Read only.
	Diode based	Analog. Read only
	Coil-capacitor (LC)	Large footprint. Under 30 bits
Transistor circuits	Polymer Electronics	Not in production or radiation hard. No UHF or above
	Silicon film	Production process more expensive than polymer

VTT/ Panipol/ Mreal pyridene tag – secret technology — Range only a few mm

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Surface Acoustic Wave (SAW) RFID Technology

Signal from Antenna to Interdigital Transducer
- Produces Pulse of Surface Acoustic Waves
- Uses Piezoelectric Crystal (not Silicon) Chip

SAW Reflections from RFID Pattern
- Produce Pulse Position Encoded Data

Pulse Train Leaving IDT
- Returns Encoded Signal to Reader

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Reading on Metal

SAW Tag with dipole antenna on coke can

Reading tags on metal, metal foil or containers of liquids is not a great problem

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Global Potential Billion/Year		RFID Leadership
Library	0.1	Singapore
Museums, art galleries	0.1	Europe
National ID cards	**0.1**	**China**
Laundry	1	Europe
Animals	**1**	**Thailand, S America, US, Eur.**
Tires	1	Europe
Military items	2	US
Blood	2	Europe/US
Test tubes	2	Europe/US
Archiving paperwork	2	US
Air baggage	**2**	**US, China**
Air freight	**2**	**US**
Drugs	30	US
Pallets, cases	**40**	**US, Europe**
Books	50	Japan
Postal	650	Europe
Retail items	10,000	Europe/Japan/US

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ITEM LEVEL IN RED

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Chipless smart labels

2nd generation chipless tags meet EPC data requirements (96 to 256 bits): **e.g.**

SAW tags (RFSAW and AirGATE Technologies)

Printed Electronics TFTGs: 40+ companies

Chipless RFID tags are only about 2% of the RFID market today by value.

They have the potential to reach the lowest cost and therefore highest volume markets – barcode replacement and more.

2014 market share may be as high as 30% as these technologies emerge.

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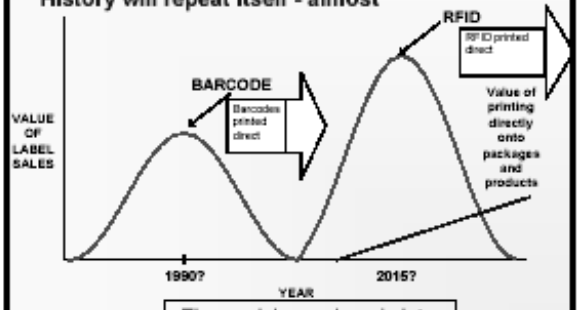
High volume item level RFID tagging
History will repeat itself - almost



The peak in numbers is later

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RFID Applications and Potential

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Consultancy
Publications
Conferences

For further information read:

Item Level RFID

Progress and activities towards tagging each item. This will lead to trillions of items being RFID tagged every year. We discuss why, where, what next and give detailed forecasts, winners and losers. IDTechEx

The RFID Knowledgebase

Over 1600 case studies listed and growing by over 50 a month. Covering more than 1700 companies, learn from the successes and failures of others. www.rfidbase.com

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