

# Synthetic Biology: Chances and Risks

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# Synthetic Biology Definition

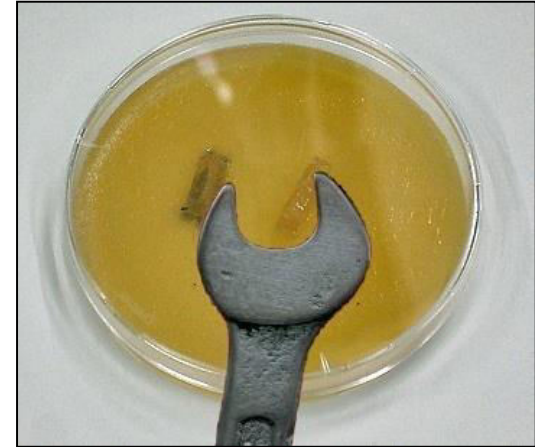


“The engineering of biology: the synthesis of complex biologically based systems, which display functions that do not exist in nature.”



The vision: “Biobricks” – Interchangeable genetic components. Programming living organisms in the same way a computer scientist programs a computer”

Craig Venter’s vision: ***“An operating system for biologically-based software.”***



## Recent news:

***“Another step in the quest to create synthetic life, by synthesizing an entire bacterial genome and using it to take over a cell.”***

***“The first self-replicating species we’ve had on the planet whose parent is a computer.”***

New York Times, 20/5/2010

**Prof. Leonard Kleinrock, UCLA (Internet Pioneer, the Dan David prize winner):**

The Internet is a perfect formula for employing the dark side of technology -

- ▶ Easy
- ▶ Quick
- ▶ No cost
- ▶ Anonymous

***“We didn’t think about it (the dark side) while developing it...”***

Tel-Aviv, 11 May 2010



# Two Relevant Insights

1. R&D in a field like Synthetic Biology and other Biological fields of research needs **time**, human resources and expertise, and technological infrastructure and knowhow. Looking ahead to the next twenty years we are in the right period for entering this era with a long range perspective.
2. Synthetic Biology promises many potential applications. One important priority field would be energy and agriculture. Synthetic Biology can result in engineering of future energy crops on the one hand and improve food production on the other hand. One can also improve the balance between these two needs of economy in the years to come.





# Synthetic Biology Applications

1. Energy Production through Photosynthesis
2. Alternative Fuels (e.g. energy plants, Bio fuels)
3. New way of Biological Energy Storage (ATP use)
4. Future Agriculture and Food Production
5. Solving Environmental Problems (pollution reduction)
6. Medicines and Medical Devices ( implants)
7. Bio sensors



# Photosynthesis

- Imagine that Synthetic Biology will enable us to construct artificial photosynthesis systems out of standard Bio building blocks(Bio-bricks). Such a system will realize three functions:

1. Light capture
2. Catalysis
3. CO<sub>2</sub> reduction

- Further imagine that these products could be introduced into walls, roofs, roads, and other existing structures. Such a combined system would thus be able to solve energy needs and prevent environmental hazards.  
(Thomace Faunce Futurist 2013)



# Challenges

- Life is not simple and so is Biology  
Complexity of living systems does not guarantee easy success of Synthetic Biology processes.
- Synthetic Biology Process could result in unwanted products. We can not rule out new emergent unexpected properties.
- Public Perceived threat of new biotechnology products should be considered  
(see GM experience)
- Safety and Security potential threats because of misuse or wrong use of the technology.





# Synthetic Biology threats

## Bio-terror

*"Ultimately synthetic biology means cheaper and widely accessible tools to build bioweapons, virulent pathogens and artificial organisms that could pose grave threats..."*



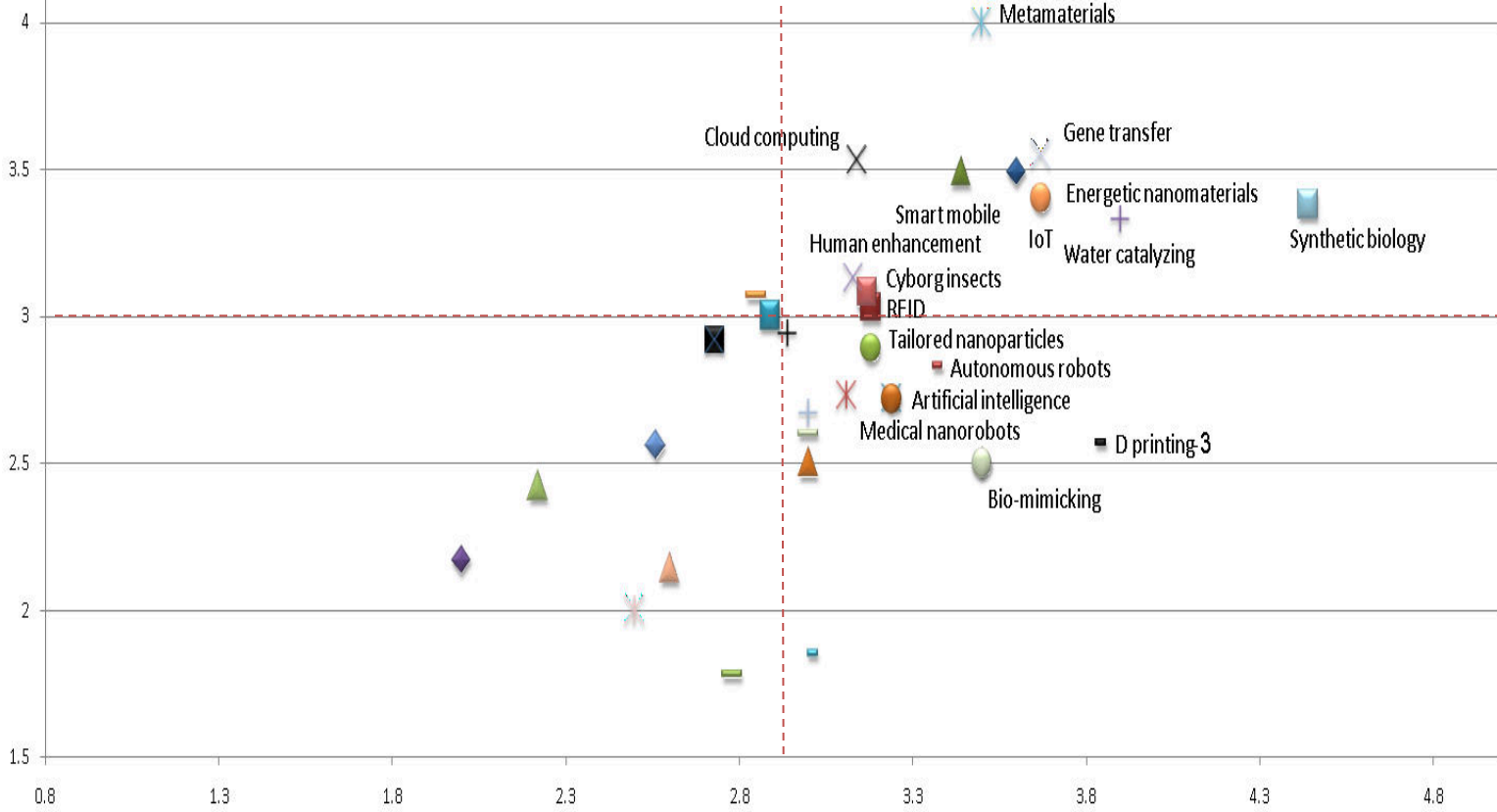
Report by Ottawa-based ETC Group (one of the advocacy groups that want a ban on releasing synthetic organisms pending wider societal debate and regulation)

# Severity vs. Likelihood to pose a security threat – max value



(1=very unlikely 5= very likely)

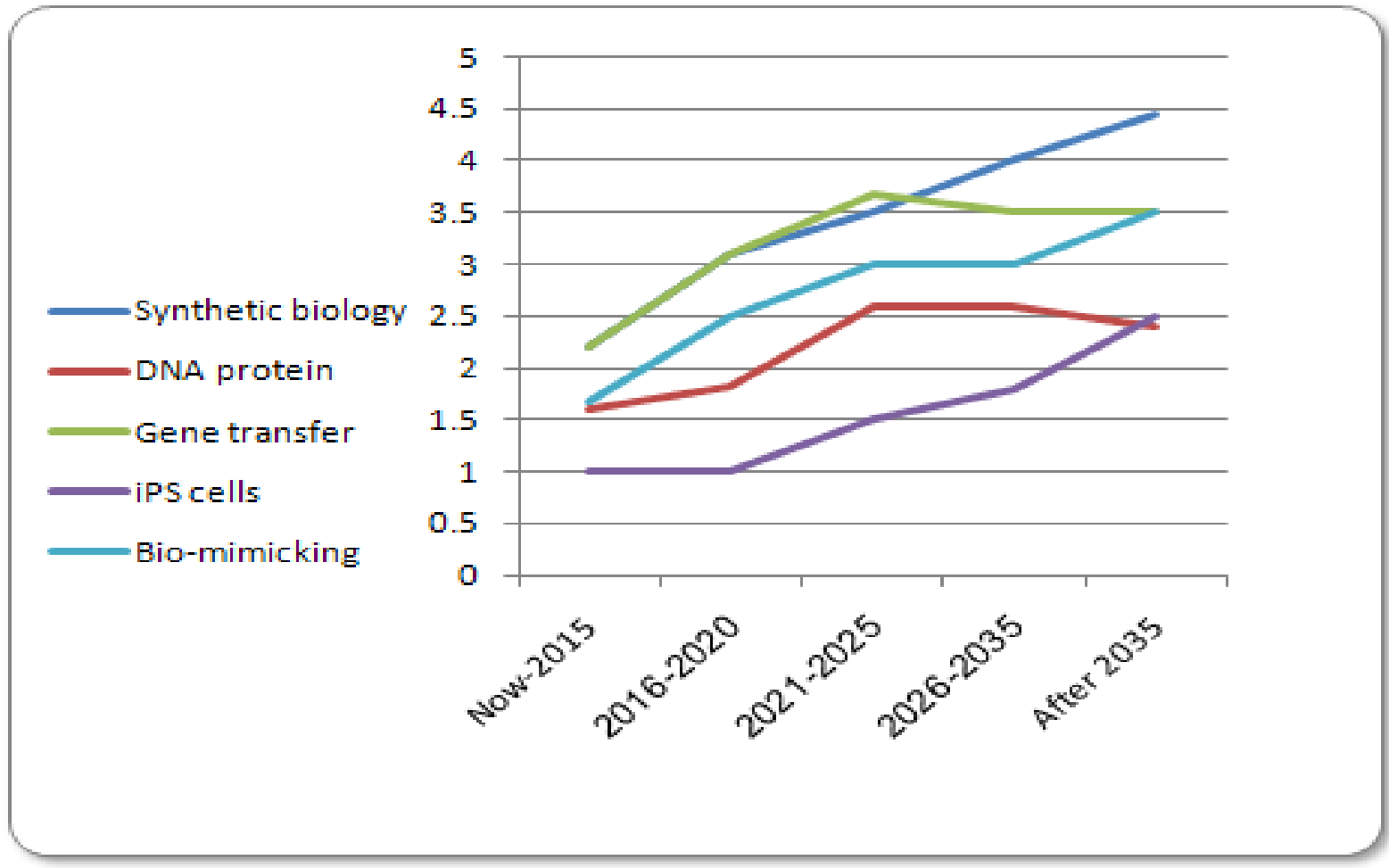
How severe is the potential security threat posed by this technology?



Likelihood to pose a security threat - maximum value

- ◆ IoT
- RFID
- ▲ Smart mobile
- ✕ Cloud computing
- ✕ Ultra-dense
- Artificial intelligence
- AI robots
- Autonomous robots
- Artificial limbs
- ◆ Ethical control
- ✕ Medical nanorobots
- Tailored nanoparticles
- + Energetic nanomaterials
- Molecular nanosensors
- Brain implants
- ◆ Brain-to-Brain
- Cyborg insects
- ▲ Brain computer interface
- ✕ Human enhancement
- ✕ Metamaterials
- Water catalyzing
- + Programmable matter
- 3-D printing
- Future fuels
- ◆ Crystalline polymers
- Synthetic biology
- ▲ DNA protein
- ✕ Gene transfer
- ✕ iPS cells
- Bio-mimicking

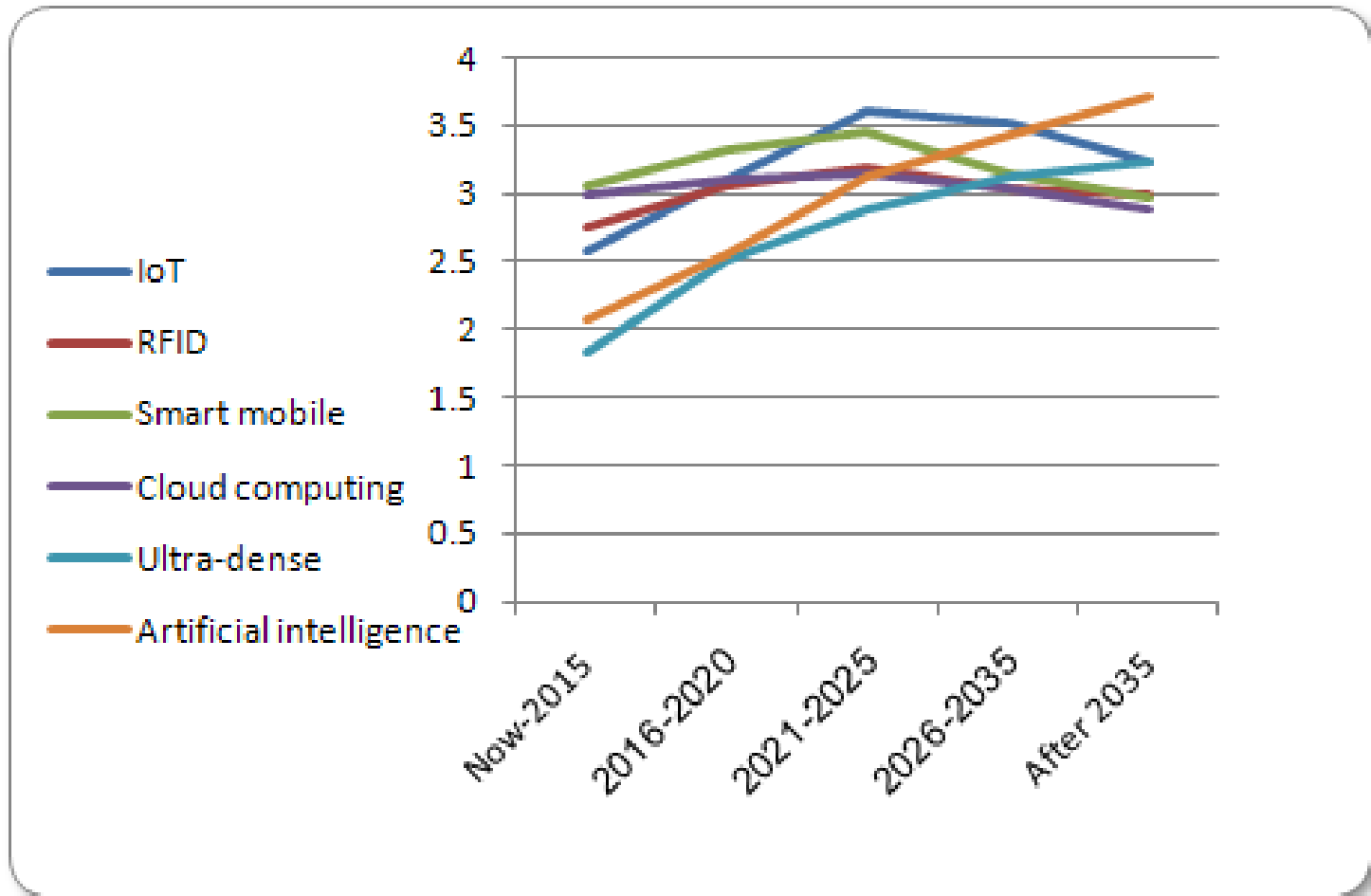
## Likelihood to pose a security threat - Biotechnology



**Source: the FESTOS project**

# Likelihood to pose a security threat - ICT

(1=very unlikely 5= very likely)



source: the FESTOS project

## CONCLUSIONS

- Biotechnology and Synthetic Biology as well as ICT and other Emerging technologies are leading us to a new era
- These technologies open to society many positive and promising opportunities that should be realized. On the other hand terrorism and crime **can** and **might** abuse them.
- Society should be aware of these developments minimize the risks and maximize the chances
- It is our **difficult** task to safeguard the new technologies and control their proliferation – without increasing public distrust in science, and without hurting the freedom of research





# Thank you

***Don't slumber in face of emerging technologies –  
they might catch you by surprise!***

