Open Innovation
and its role in a
Nano-Enabled Solar Industry

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Nanotechnology can enable a new generation of more efficient, lighter, more versatile photovoltaics, but nano-enabled solar companies are struggling.

Research question: Could problems facing nano-solar and supporting technologies be attenuated using open innovation?

Open Innovation: a new paradigm for the creation of complex information goods that defines ownership of intellectual property in terms of rights to distribute rather than rights to exclude

Methods

- Compare open hardware, about which less is known, to open software, about which much is known

- Build dependency tree for open hardware projects

- Look for any pattern which might suggest what can and can not soon be achieved in open hardware

- Conduct interviews with nano-solar companies to understand their current challenges and practices

- Compare the requirements indicated in these interviews with the conditions favorable to open innovation

Mapping Dependencies
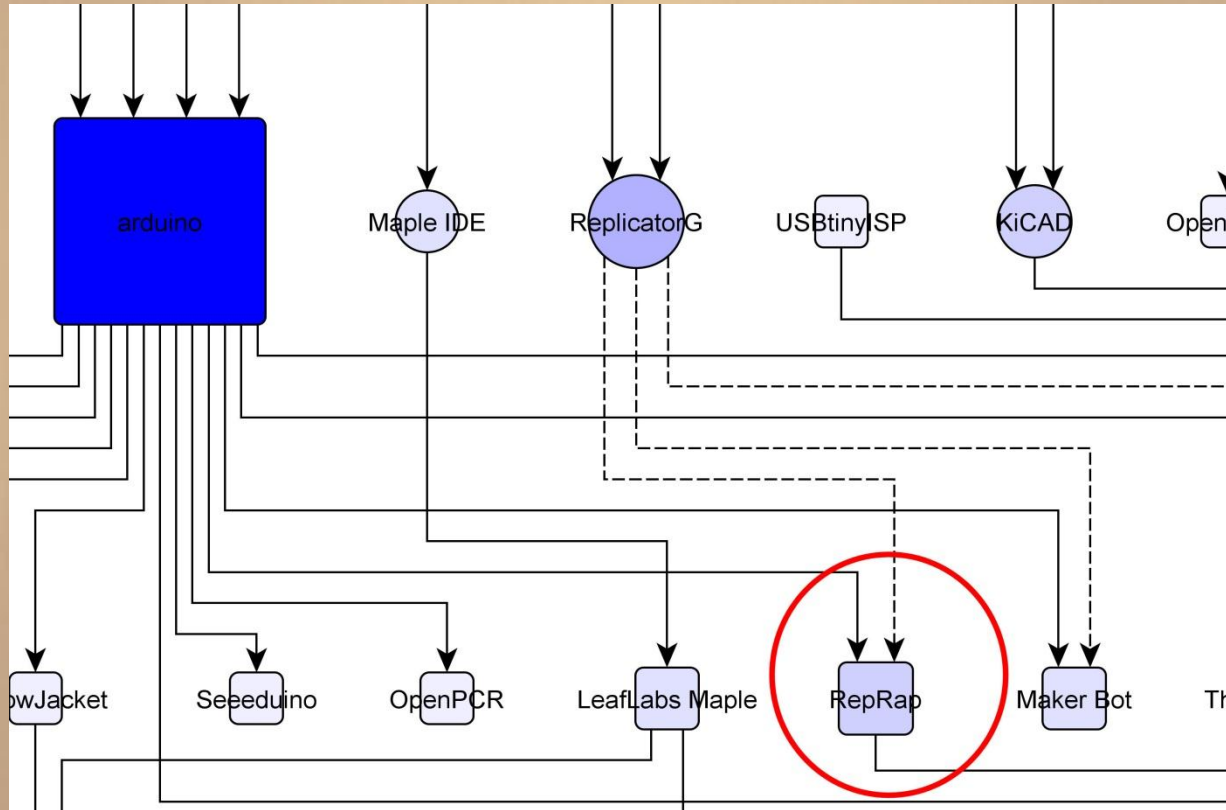
- Circles indicate software

- Squares indicate hardware

- Consider this example, the RepRap 3D printer

Overall structure of the map
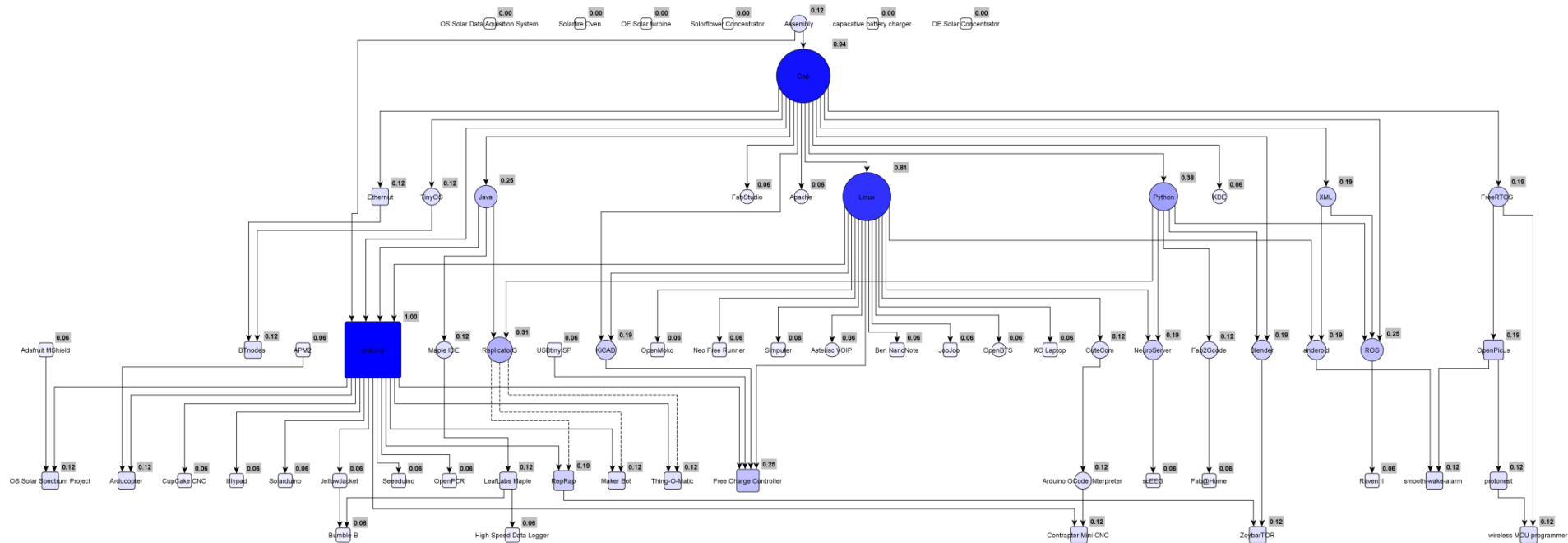
- The diagram reveals five distinct layers of dependency, or 'generations' of open source technology

- We have collected additional data, such as the number of person-years invested and project release dates

Five generations appear in tree

mean dates of each generation and typical products

- 1983- Free Software Foundation starts GNU, C++ released

- 1997- networking software, high level languages, operating systems

- 2006- simple single board computers, 3D software, Networking/IO hardware

- 2009- CNC machines, 3D printers, Drone robots

- 2011- more advanced versions of 4th generation items, computers with full range of features such as integrated wifi, wireless sensor networks

2012 has already seen OS surgical robotics

The open innovation community appears to have the technical ability to develop the required devices

- Average release dates for items in each generation are separated by intervals of 14.5, 8.5, 3, and 2 years.

- Many components required to build a solar economy already exist in OS generation 4 and 5, though PV itself and improved storage are notably lacking

Conditions Favorable to Open Innovation

- opinions of incumbent technologies are negative

- People hold a positive normative or ethical valence toward the technology

- The technology is modular

- Many variations are required for specialized applications

- No central node requires hierarchical control

  (solution is distributed)

Based on "The Success of Open Source", by Dr. Steven Webber, Professor at University of California, Berkeley

Interview Results

"For solar,... there's no one size fits all."

- John Wood, CEO of Ecoult,

Developers of a breakthrough battery technology

"We strongly support a distributed energy model"

- Marc Thomas, CEO of DyeSol,

Producers of materials for dye-sensitized solar

"[the] Solar industry is not a very collaborative industry"

-Siva Siviram, CEO of Twin Creeks Technology,

Pioneering company in Proton Induced Exfoliation

Interview Results Continued

- Nano-enabled solar industry growth is limited in part by underdeveloped supporting technologies

- Henning Richter, CEO of Nano-C, a manufacturer of carbon nano-tubes, describes a 'chicken and egg problem' with high performance panels and infrastructure

- Our long term solar solution should be modular and distributed, with many variations to address local climates and energy needs

Contributor Motives

- Open Innovation communities are motivated by a common enemy and/or shared goals[1]

- The public has a "negative attitude toward oil companies in general", and "increasing concern for the environment" [2]

- In 2011, 88% of Americans thought the US should rely more heavily on solar power[3]

1. Based on "Open Innovation", 2004, by Dr. Henry Chesbrogh, adjunct professor and executive director of the center for Open Innovation at the Haas School of Business at the university of California, Berkley
2. "Trends in Public Perceptions and Preferences on Energy and Environmental Policy" by Barbara C. Farhar at the National Renewable Energy Laboratory, a national laboratory of the US Department of Energy
3.CNN Opinion Research Poll released by the Opinion Research Corporation on March 18-20, 2011

Conclusions

- The open source community may have the motivation and the means to develop and support a wide range of components required to build a new energy infrastructure around and including nano-solar technology

- Nano-solar companies should consider adopting open innovation practices in order to parallelize their continued development, accelerating the growth of the industry (in which their positions of leadership may remain based on tacit knowledge)

Implications

Our energy future may depend not on competition, but on a collaborative effort on the part of entrepreneurs, universities, start-ups, and private individuals. Closed, vertically integrated research and development methodologies and pure capitalist competition is failing to deliver solutions to pressing problems, and the solution may lie in seeing past this illusion of a zero-sum game.

Efficiencies of various PV technologies

	module	lab	theoretical
Crystalline Si.	15-22	25	26
Thin Film	9-12	20	22
Dye-Sensitized	6-9	12	14-20

(Source: Kevin Sivula
Tenure-Track Assistant Professor
École Polytechnique Fédérale De Lausanne)

Henry Chesbrogh argues in "Open Innovation" that when an industry has many open source components, companies controlling critical nodes in the value network can leverage the value of the OS portion, adding massive value to their own products at little cost.

Those companies which own breakthrough technology should consider developing some supporting devices and releasing them to the public as open source in order to seed the industry and allow the public to build the infrastructure on which their commecrial success will depend