

Skynet Has Arrived

Ubiquitous Connectivity, Testing, and Quality



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Skynet Attacks

- In the popular “Terminator” movie series, Skynet becomes self-aware – or is that “alive”?
 - Skynet starts as a military Internet of Things
 - It’s programmed for autonomous control of all US defense (think “drones controlled by AI”)
 - Skynet starts to collect knowledge as part of its AI
 - Once a certain level of knowledge is reached, Skynet becomes self-aware
- One self-aware, Skynet starts a war between humans (US vs. Russia), then attacks the surviving humans
- Contrast Cameron’s bleak vision of self-aware, hyper-networked computers with:
 - Heinlein’s *The Moon is a Harsh Mistress*
 - Card’s *Ender’s Game* series



Other Views

- *Johnny Mnemonic*: that ain't no ordinary SD Card you got behind your ear, son...
- *Neuromancer*: romance, human (Case-girlfriend) and computer (Wintermute-Neuromancer)... Gibson again
- "Transcendence": a human consciousness running on a quantum computer isn't human...or is it?
- *I, Robot*: self-aware, childlike, and aspiring to be good (by design)...Asimov's vision
- "Blade Runner" / ...*Electric Sheep*: the violent, amoral, but ultimately sympathetic and enslaved self-aware androids...Dick's reply to Asimov?



Where Is this All Headed?

- We sure are conflicted about where software is headed...at least, that's what art would tell us
- But what does engineering tell us?
- What are the risks of the Internet of Things, cyborgs, and singularity?
- How about the benefits?
- Can we even make this stuff work?
- What are the broader implications?



What Are the Technologies?

- Internet of Things (IoT): “objects, animals or people with [IP addresses] and the ability to transfer data over a network [directly]” [whatis.com]
- Cyborg: cybernetic organism; a person or animal augmented with mechanical (often robotic) components
- Singularity: Kurzweil’s theory that exponential progress in computers will converge with humans, with transformational results



Internet Fridge

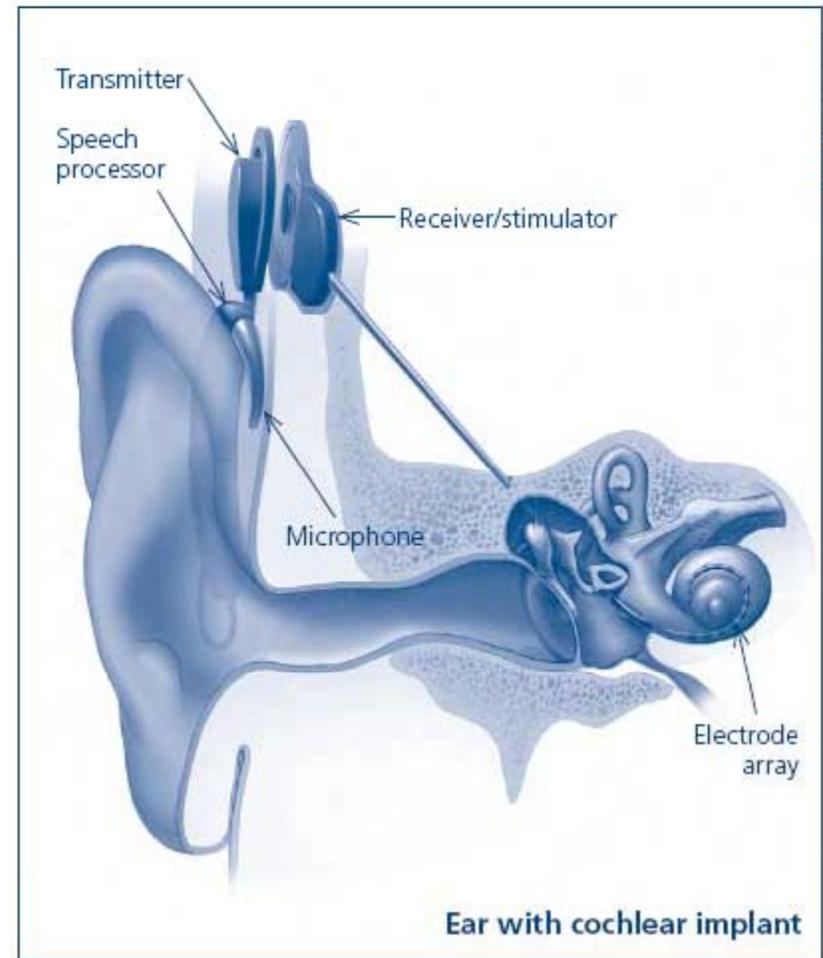
- Okay, this isn't so scary
- The computer in the fridge doesn't make things move
- It just provides information
- Of course, a bug could cause weird or excessive orders
- "Honey, why do we have 16 gallons of milk and a whole suckling pig in the fridge?"





Cochlear Implant

- This is another information-providing device, but it's surgically implanted
- This device has changed the lives of over 300,000 people
- It also saved Rush Limbaugh's career (which you might or might not be happy about)
- Eventually, this could move beyond treatment to augmentation





Robotic Arm

- Thanks to this arm, this woman can move again
- “One small nibble for a woman, one giant bite for BCI (brain-control interfaces),” she said
- Here’s where Kurzweil’s singularity starts to kick in
- This arm integrates into the brain itself
- She’s able to make a physical object move in the real world with her mind
- In fiction, this has been called telekinesis...and now its for real
- Imagine all the wounded military, accident victims, etc., who can benefit





So Far, So Good, But...

- These three examples are clearly good
 - You can't argue with restoring hearing or mobility
 - The Internet fridge may seem silly, but it's part of a long tradition of efficiency improvements in household appliances
- And, if these things fail, the impact is limited
- However, there are scary examples, too





Self-driving Cars

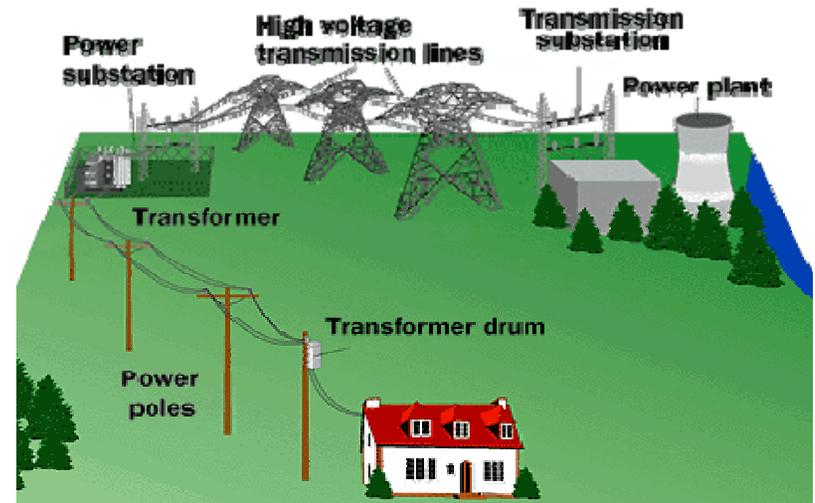
- Touted as safer than human drivers – and maybe they are – there's still risk here
- There are about 10MM vehicle accidents per year in the US, with about 36,000 fatalities
- Suppose software-driven cars are 100 times safer: Will society tolerate 100,000 accidents, with 360 people killed, due to software annually?
- Further, significant legal and insurance issues must be addressed
- Finally, how long before criminals and hackers figure out how to penetrate these vehicles for nefarious purposes?





The Power Grid

- ⊕ The power grid has become more and more computerized
- ⊕ This has made it vulnerable to hacking
- ⊕ Persons unknown have installed malware
- ⊕ Software bugs contributed to an August 2003 blackout
- ⊕ Power outages for a few hours are a hassle
- ⊕ A power outage that lasted days would have major safety implications and cost millions of dollars





The IoT Is Watching You

- ✚ Lots of opinions, but two certain facts about Snowden
 - ✚ He revealed the weakness of NSA's security systems
 - ✚ He revealed the extent to which 100% connectivity can also mean 0% privacy
- ✚ The IoT has created the potential for the same kind of dystopia described in *1984*
- ✚ This ubiquitous data collection can also be used by pranksters and criminals
- ✚ As with driverless cars, the law needs to catch up with the technology





What are the Testing Issues?

- ✚ What's the test basis?
 - What does *coverage* mean?
 - How do you identify, then test for, future scenarios?
- ✚ What're the test oracles?
- ✚ How do we even test some of these things?
- ✚ Like the early days of the space program
- ✚ Except the experiments will involve all of society





Are We Even Up to the Task?

- ⊕ Modern manufacturing is capable of six sigma levels of quality: three defects per million items
- ⊕ In software, according to Jones' studies, we release over 13,000 defects in a typical million-line C++ program
- ⊕ Even RBCS clients that achieve 99% DDE will still release close to 1,000 defects in similar-sized software
- ⊕ Ultimately, software quality must increase dramatically if we are to realize the potential of these advances
- ⊕ Software engineering must become true engineering



Conclusions

- ❖ Popular entertainment, literature, and art have taken a generally dim view of technological progress
- ❖ The reality is, of course, more nuanced and harder to predict
- ❖ Both tremendous potential benefits and tremendous risks exist, side by side
- ❖ Law and culture will need to keep pace with technology
- ❖ Our own capabilities as professionals must expand dramatically to avoid disasters



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