



A.I.

APOCALYPSE



WILLIAM HERTLING

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PRAISE

Praise for *Avogadro Corp: The Singularity Is Closer Than It Appears*

“Highly entertaining, gripping, thought inspiring. Don’t start without the time to finish — it won’t let you go.”

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“A tremendous book that every single person needs to read. In the vein of Daniel Suarez's *Daemon* and *Freedom(TM)*, William's book shows that science fiction is becoming science fact. *Avogadro Corp* describes issues, in solid technical detail, that we are dealing with today that will impact us by 2015, if not sooner. Not enough people have read these books. It's a problem for them, but not for the [emergent] machines.”

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“An alarming and jaw-dropping tale about how something as innocuous as email can subvert an entire organization. I found myself reading with a sense of awe, and read it way too late into the night.”

—Gene Kim, author of *VISIBLE OPERATIONS*

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For my parents. Thank you.

TITLE PAGE

A.I. Apocalypse
Singularity Series

William Hertling

CHAPTER ONE

A Regular Day

Leon's phone buzzed, beeped, and shrilled at him until he reached one arm out from under the flannel covers and swiped his fingers across the display to stop the alarm. Eyes still closed, he shrugged off his blankets and stumbled towards the bathroom, a trip of only a few steps, hitting himself just twice along the way: once walking into his closed bedroom door, and the second time on the corner of the bathroom sink. He turned on the water, and leaned against the white tile wall waiting for the spray to get hot.

When he was done in the shower, he wrapped himself in a towel and walked more alertly to his room, steam rising faintly off his body in the tiny apartment's cold morning air. The superintendent wouldn't turn on central heating for another month, regardless of whether it was cold or not.

It was quiet in the apartment, his parents already at work. He grabbed yesterday's dark blue jeans off his chair and pulled them on. On his desk was a deflated bag of cookies and an empty bottle of soda, evidence of his late night Mech War gaming session. He dug in a pile of clean laundry his mom had deposited inside his door until he found his vintage I(heart)SQL t-shirt. It was obscure enough that no one at school would understand it. They'd probably think it was some new band.

He grabbed his phone and shoved it into his pocket. He thumbed his desk, unlocking the drawers, and pulled out a locked metal box decorated with stickers carefully layered over each other to form, in aggregate, a picture of a plant growing out of a heap of garbage. An artifact of a girl from last year, he both treasured and was embarrassed by it. In the depths of the box, he rummaged around until he found rolling paper and some non-GMO weed, which he put into a jacket pocket. He fumbled through the container again, anxiously looking for his cigarettes, until he finally found them inside the empty cookie bag. He shook his head, wondering why he had put them there.

Leon walked the few steps down the short hallway to the kitchen. He shook cereal into an old cracked white porcelain bowl and followed with cold milk. He gently bumped his phone on the table, activating the wall display next to the table and syncing it to his phone. He surfed the in-game news while he ate, and checked out the game stats. He was ranked twenty-third on his favorite Mech War server, up ten spots due to the new genetic algorithms he'd written for targeting control. He had some ideas for an anti-tracking algorithm he wanted to try out next.

When he finished slurping cereal, he grabbed his backpack and headed out the door, securing all the locks. His Russian immigrant parents thought you could never be too secure. In addition to the electronic building lock and a digital fingerprint deadbolt, they had an actual antique key lock. Leon wore the key around his neck sometimes, and half the kids at school assumed it was a curious kind of jewelry.

He walked the few blocks to South Shore High School. Hundreds of kids streamed across Ralph

Avenue, ignoring the cars. Drivers angrily honked their horns as their vehicles' mandatory SafetyPilots cut in automatically. Leon ran across with a group of other kids, and funneled through the front door with them.

* * *

Leon made his way into first period, math. James was already there, wearing his usual army green flannel jacket. Leon's Russian heritage gave him blond hair and a tall, large frame, but James still had an inch or two in height and a solid fifty pounds on him. He punched James on the arm as he went in, and James punched him back. The bell rang, and they hurried to their desks in the back row. Moments after everyone else sat down, Vito flew through the doors and slid into his seat next to them, earning a glare from the teacher.

They might have been the three smartest kids in school, but they tried to keep that secret. They didn't fit in with the Brains. Preppy clothes and drama club seemed ridiculous. Though the football team would have loved James, James would rather be playing MMORPGs. They surely didn't fit in with the popular kids and their shallow interests. They weren't skaters or punks. They might have been labelled geeks, but the geeks rarely came in wearing military jackets or ditched school to smoke pot. They were too smart and had too much of the hacker ethic to fit in with the stoners.

No, they were their own clique, and they made sure not to fit anyone else's stereotypes.

Leon glanced over at Vito, who was fiddling with his ancient Motorola. Vito lavished care on the old phone. The case was worn smooth from thousands of hours of polishing from Vito's hands. Even the original plastic seams had disappeared with age. When a component died, Vito would micro-solder in a replacement. Vito said that after a certain point the phone just didn't get any older, it just got different.

Leon daydreamed through the class, volunteering a correct answer only when the teacher called on him. In his mind he was walking the ruins of Berlin in his mech, replaying the scenes of last night's gaming.

He thought about writing a new heat detection algorithm for his mech. The current generation of games required custom programming to do well. Leon knew from history class that a long time ago the marketable commodity in games was gold and equipment. Now it was algorithms. The game made available the underlying environment data, and it was up to the player to find the best algorithms for piloting, aiming, detecting, moving, and coordinating mechs. There was a persistent rumor that DARPA had funded the game as a way of crowd-sourcing the all-important algorithms used to control military drones. Leon couldn't find any solid evidence online to prove or disprove it.

No, maybe he should focus on a new locomotion algorithm. He'd heard that some mechs, using custom locomotion code, were coaxing ten percent more speed and range while keeping their thermal signatures lower. If that was true, Leon could sell it on eBay for top dollar.

Leon became more deeply immersed in the problem, and when the bell rang, only James whacking him on the head woke him from his thoughts.

"See ya later, Lee," Vito called, heading off to another class.

"Adios."

Leon and James walked together to their social studies class.

"How are your applications coming?" James asked.

"OK, I think," Leon said. "I just finished the MIT application. I aced the qualifying exams. Dude, I

sucks though. If I don't get a scholarship, I'm screwed."

"You and everyone else, man." James clapped him on the shoulder.

* * *

"Okay class, who can explain the legal and political significance of the Mesh?" Leon's social studies teacher looked around. "Josh, how about you?"

Josh looked up from his desk, where he appeared to be scribbling football plays. "Uh?"

"The mesh, Josh, I was asking about the mesh."

"Mesh, uh, helps keep you cool on the field?"

The uproar of laughter from the class drowned out the teacher for a moment. "Very funny. Come on someone. This is how you play games, watch TV, and get information. Surely someone has cared enough to figure out how all those bits get into your house."

Leon rolled his eyes at James and mock yawned.

"How about you, Leon? I'm sure you know the answer to this."

Leon hesitated, weighing the coolness impact of answering, then reached a decision. He felt sorry for the teacher. "The Mesh was formed ten years ago by Avogadro Corp to help maintain net neutrality," he began.

"At the time, access to the Internet in the United States was mostly under the control of a handful of companies such as Comcast, who had their own media products they wanted to push. They saw the Internet as competing with traditional TV channels, and so they wanted to control certain types of network traffic to eliminate competition with their own services."

"Very good, Leon. Can you tell us what they built, and why?"

Leon sighed when he realized his teacher wasn't going to let him off easy. "According to Avogadro it would have been too expensive and time consuming to build yet another network infrastructure comparable to what the cable and phone companies had built last century. Instead they built MeshBoxes and gave them away. A MeshBox does two things. It's a high speed wireless access point that allows you to connect your phone or laptop to the Internet. But that's just what Avogadro added so that people would want them. The real purpose of a MeshBox is to form a network with nearby MeshBoxes. Instead of sending data over the Internet via Comcast, the MeshBox routes the data packets over the network of MeshBoxes."

Leon hadn't realized it, but sometime during his speech he had stood up, and started walking towards the netboard at the front of the room. "The Mesh network is slower in some ways than the traditional Internet, but faster in other ways." He drew on the touch-sensitive board with his finger. "It takes about nine hundred hops from one MeshBox to the next to get from New York to Los Angeles, but only about ten hops from one router to the next by Internet backbone. That's a seven-second delay by Mesh, compared to a quarter-second by backbone."

"But the aggregate bandwidth of the Mesh in the United States is about four hundred times the bandwidth of the backbone because there are more than twenty-million MeshBoxes in the United States. More than a hundred-million around the world. That means the Mesh is bad for phone calls and interactive gaming unless you're within about two hundred miles, but it's great for moving files and large data sets around at any distance."

He paused for a moment to sketch a stylized computer on the netboard. "But the real benefit of the

Mesh is that it's completely resistant to intrusion or tampering, way more so than the Internet ever was before the Mesh. If any node goes down, it can be routed around. Even if a thousand nodes go down, it's trivial to route around them. The MeshBoxes themselves are tamperproof - Avogadro manufactured them as a monolithic block of circuitry with algorithms implemented in hardware circuits, rather than software. So no one can maliciously alter the functionality. The traffic between boxes is encrypted. Neighboring MeshBoxes exchange statistics on each other, so if someone tries to insert something into the Mesh trying to mimic a MeshBox, the neighboring MeshBoxes can compare behavior statistics and detect the wolf in sheep's clothing. Compared to the traditional Internet structure, the Mesh is more reliable and secure."

Leon looked up and realized he was standing in front of the class. On the netboard behind him he had drawn topology diagrams of the backbone and mesh. The entire class was staring at him. James made a "what the hell are you doing?" face from the back of the room. If he had a time travel machine, he'd go back and warn his earlier self to keep his damn mouth shut.

The teacher, on the other hand, was glowing, and had a broad smile on his lean face. "Excellent, Leon. So Avogadro was concerned about net neutrality, and created a completely neutral network infrastructure. Why do we care about this today?"

Leon tried to walk back to his desk.

"Not so fast, Leon," the teacher called. "Why exactly is net neutrality so important to us? This isn't a business or science class. We're studying national governments. Why is net neutrality and net access relevant to governments?"

Leon glowered at a corner of the room and sighed in defeat. "Because in 2011, the Tunisian government was overthrown, largely due to activists who organized on the Internet. Egypt, Syria, and other countries tried to suppress activists by shutting down Internet access to prevent the uncontrolled distribution of information. The Mesh didn't just disrupt Internet providers, it disrupted national government control over the Internet. Instead of a dozen or fewer international connections that could be shut down by a centralized government, the Mesh network within any given country has thousands of nodes that span national borders. When governments tried to enforce wi-fi dead zones around their borders, Avogadro responded by incorporating satellite modems in the Mesh boxes so that any box, anywhere on Earth, can access Avogadro satellites when all else fails. Between Mesh boxes and WikiLeaks, it's impossible for governments to restrict the flow of information. Transparency rules the day."

"Exactly. Thank you, Leon, you can sit down. Class, let's talk about transparency and government."

Leon slumped back to his desk.

* * *

"Nice going, dork," James called after class. "What happened to not sticking out?"

"Look, the Mesh is just cool. It's the way nature would have evolved electronic communications. Cheap, simple, redundant, no dependency on centralization. I couldn't help myself."

"Yeah, well, have fun in history. Maybe you can give your class a lecture on Creative Commons." James's tone mocked Leon, but when Leon looked up, he saw the corner's of James mouth edging toward a smile.

"Yeah, sure," Leon said, smiling back. James turned and left, off to another class.

Leon headed into his own class and started to settle into his chair when his phone started a high

frequency shrill for an incoming message. Leon pulled it out to read the message.

Leon, this is your uncle Alex. I hope you remember me - when I was last in New York, I think you were ten. I hear from your parents that you are great computer programmer.

Leon rolled his eyes, but kept reading.

I am working on programming project here in Russia, and I could use your help. I have unusual job that your parents don't know about. I write viruses for group here in Russia. They pay very good money.

Leon leaned forward, paying very close attention to the email now. Writing viruses for a group in Russia could only be the Russian mob and their infamous botnet.

I run into some problems. Anti-virus software manufacturers put out very good updates to their software. Virus writers and anti-virus writers have been engaged in arms race for years. But suddenly anti-virus writers have gotten very, very good. No viruses I write in last few months can defeat anti-virus software.

You realize now I talking about running botnet. Because of anti-virus software, botnet shrinking in size, and will soon be too small to be effective.

Unfortunately, although pay is very good, you must realize, men I work for are very dangerous. They are unhappy that

“Leon. Are. You. Paying. Attention?”

Leon looked up abruptly. The whole class was staring at him.

“Can you tell us why the colonies declared independence from Great Britain?”

Leon just stared at the teacher. She was talking, but the words seemed to be coming from far away. What was she babbling about?

The teacher went over to her desk. “Mr. Tsarev, will you please pay attention?” It was not a question.

Leon just nodded dumbly, waited until she turned his back, then went back to the email.

They are unhappy that botnet is shrinking and give me two weeks to release new virus to expand botnet. Nothing I try has worked. I have one week left, and I am afraid they will

“Mr. Tsarev.” Leon looked up, to find her now looming over him. “Do I need to take your phone away?”

“But how would I take notes?” Leon asked in his best innocent voice.

“That might be an issue if you were actually listening, but since you are not, I think taking notes is the least of your worries.” She walked back up to the front of the room, keeping an eye on Leon the whole time. In fact, she didn't glance away from Leon for the entire remainder of the class.

As soon as Leon could get out of the classroom, he headed over to the corner of the hallway to finish reading the message.

I have one week left, and I afraid they will kill me if I don't deliver new virus. Nephew, your parents go on and on about your computer skills, and I must know if there is truth to their words. If you can assist me, please contact me as soon as possible. I give you much of the necessary background information on how to develop viruses: source code, examples, details on mechanisms that antivirus software uses. There is not much time left.

Whatever you do, please do not speak of this to your parents.

Leon lifted his head from the tiny screen of his phone and looked off into the distance. He remembered a Christmas when he was young and his uncle had come to visit from Russia. Leon's father had cried when his brother came into their tiny apartment. During the days that followed, all through that holiday time, Leon's parents were as happy as he could remember seeing them. His parents were so serious most of the time, but he vividly remembered them laughing merrily, even as Leon lay in bed at night trying to go to sleep.

The idea of writing a virus seemed absurd, and the idea that someone would be killed if he didn't seemed no less absurd. What could he do?

He worried about it all through his next class, English. James sat next to him and threw tiny balls of paper at him. Leon just covered his ear, James's likely target, and pretended to listen to the teacher, but he couldn't stop thinking about the email. He just couldn't reconcile the kindly man who had bought him a bicycle for Christmas with the idea of a man who worked for the mob writing viruses. And if there was one thing that Leon's parents had hammered into his head, it was that he had to stay out of trouble. His family didn't have the money to send him to college, which meant that he needed scholarships, and scholarships didn't go to kids who got into trouble.

He hated to let his parents' logic dictate his own thinking, but there it was. He wanted to become a biologist. That meant going to a great school - he hoped for Caltech or MIT. No, helping his uncle would be a quick path to nowhere good.

Uncle Alex,

Of course I remember you! I appreciate your confidence in me, but I really know nothing about writing viruses. Yes, I know something about computers, but it's mostly about gaming and biology. I don't think I can help you

Leon

Speaking of biology, it was up next. The thought of his favorite subject brought a smile to his face. He couldn't say what it was he liked so much about biology, but it was undeniable that it was the one class he looked forward to every day.

Of everything in school, biology had the most thought provoking ideas: Life could emerge from anywhere. With no direction, it could evolve. Everything people were, was happenstance and survival. Life could be tampered with, at the most basic building block level, to create new life forms. The possibilities were limitless and spontaneous.

* * *

Today's biology class focused on recombinant DNA, the technique of bringing together sequences of DNA from different sources to create new arrangements not found in nature. At the end of class Leon headed for the door, deep in thought about canine DNA. Suddenly, Mrs. Gellender blocked the doorway.

"Do you have a minute, Leon?"

Leon looked around to see if any of his friends noticed him. All clear. He nodded.

"I'm starting up a school team for computational biology. There's going to be new intramural league in New York. I think you'd be perfect. We're going to meet after school."

Leon liked Mrs. Gellender. He really did. He loved biology. And part of him was interested, really interested. But man, oh man, how uncool it would be. And staying after school - that would suck.

Mrs. Gellender must have seen the look on his face. "You've done excellent work in my biology class. The paper you turned in on evolution was absolutely inspired. I loved the way you linked biological evolution to game theory."

Leon felt his face growing red. If there was one thing worse than having to stay late to talk to a teacher, it was having them gush over your work. How embarrassing was she going to make this?

"Just think about it. Please. Being a member of the team would really help you when it came to college scholarships." Mrs. Gellender held out a shiny pamphlet.

Leon took the pamphlet, and heard the words coming out of his mouth. "OK, I'll do it."

He walked away from the room. College scholarships. If he was going to college, any college, he'd have to get a scholarship. His mother was a manicurist, and his father was a graphic artist. They

weren't exactly rolling in money.

He finally walked down the now empty hallways of the school towards the main entrance. As he passed through the doors, he was assaulted from both sides. "HAIYAA" came the kung-fu style cry, and Leon jumped back.

James and Vito stood laughing. Heart pounding, Leon said, "You idiots, you're gonna give me a heart attack."

"You want a heart attack, look at this."

James reached into his coat pocket and pulled out an ebony slab. He held it out for Leon to take. Leon unconsciously licked his lips and gingerly took it from him. It was the darkest, most matte black Leon had ever seen. It felt slightly warm, like a piece of wood that had been sitting in the sun. Leon turned it over and over in his hands. There was not a seam or mark anywhere on the case. An absolutely perfect surface.

"The Gibson," Leon muttered in awe.

James nodded proudly. "I got the delivery notification and skipped class to run home and get it."

Leon couldn't stop marveling at the hunk of electronics in his hands, feeling the dense weight of it. The Gibson had the first carbon graphene processor. Two hundred fifty-six processing cores at the lowest power consumption ever manufactured. Full motion sensitive display. It had taken Hitachi-Sony six years to perfect the technology.

"OK, give it back already."

As James took back the phone, it came to life in his hands. Each square inch of the case was a display, and the patterns rolled as James swiped at it. "Come on, let's go back to your place and play Mech War. I want to see how this puppy does."

Leon just nodded, his six month old Chinese copy of Hitachi-Sony's Stross phone feeling ancient.

* * *

Late that night, Leon cleaned the mess of plates and glasses out of his bedroom and brought them back to the kitchen as quietly as possible to avoid waking his parents. James and Vito had stayed right up until dinner time finishing out a Mech War mission together. James's new Gibson phone blew them out of the water. It rendered video in such incredible detail that time after time Leon and Vito would ignore their own screens to watch James's screen.

But when his mother announced that dinner was cabbage soup, it had sent James and Vito scrambling for their own homes, suddenly remembering that they were expected by their parents.

Three hours later, his parents were finally asleep and Leon had time to look at the message he was trying so hard to ignore. So why was he cleaning his bedroom? Anything to avoid that message.

He gave up, and slumped down on his bed. With a flick on his phone, he plunged the room into darkness so he could see the city lights out his sliver of a window. He brought the phone back up.

Leon, I think you do know thing or two about programming. I saw your school grades, your assessment test scores, and remarks from your teachers. I think you can help me, but perhaps out of moral quandary you refuse to. Well, consider this, I will likely be dead in few days if you do not help me.

So if you must consider what is right and what is wrong, think how your father would feel if he knew you could help me but didn't.

Leon felt sick to his stomach reading the message. His father would not want him to do something wrong. But his father also wouldn't want anything to happen to his brother. He thought again of Uncle Alex's visit and his father laughing and smiling. What the hell was he supposed to do? If he told his

parents, which his uncle had said not to do, they would be worried sick about it.

~~I wanted to keep your name out of this, but they have read my emails to you, and know you could help. They may come to visit you. Be very careful.~~

Crap - how could this get any worse? He didn't want to be any part of this! He almost threw his phone down, but instead pulled the hunk of silicon close and cradled it instead.

CHAPTER TWO

Beginnings

Mike Williams pulled into the parking lot, the electric whine of the Jetta's motor slowing. He parked alongside the building, ignoring the fleet of shiny new Hondas in the main parking lot. The corporation leased the lot to the shipping port so it wouldn't appear empty. Glancing into the rearview mirror, he did a double-take. When did he get so much gray hair? Well, nobody said this job was going to be easy. With a sigh, he exited the car.

Mike walked up to the mammoth building's small front entrance and nodded to the camera. "Hello Mike," he heard over a speaker, and the door clicked as it unlocked. He pulled the tinted glass door open, and passed into the warm interior. Industrial carpeting, neutral paint tones, and bland art helped it look exactly like it was supposed to: just another generic office building in an industrial complex. An empty reception counter stood in front of Mike.

He shrugged out of his raincoat, and threw it over the top of a passing robot. The robot stuttered to halt, its optical sensors blinded by the opaque covering. "Very funny," it said and reversed direction, using its inertial guidance sensors to dead reckon its way back to within a few inches of Mike.

Mike grabbed the jacket. "I don't think robots go with the office disguise, ELOPe. Now, will you please unlock the doors?"

He heard the thunk of magnetic bolt locks opening, and a set of steel double-doors ahead of him swung open, revealing themselves to be even sturdier than they appeared from the outside. Mike passed through into his real office. Ignoring the twenty foot screen that encompassed one wall, he settled into a comfortable black leather chair. "So how are you doing today?"

"I'm fine, Mike, and you?"

"Good, although I hit hellish traffic on the way in, and I really need a cup of coffee."

"I noticed the traffic. Would you care to have me route the traffic out of your way in the future? Vehicles in the carpool lane are required to be under automated guidance. I could easily move those vehicles to give you an unimpeded route."

A small orange utility bot wheeled up, grasping a mug of coffee in one manipulator arm. Mike took the steaming cup and sipped. Late harvest Peruvian, he guessed. Too bad. Hopefully there would be some better yields at higher elevations. The robot scurried away.

He turned his attention back to ELOPe. "Don't you think that would be suspicious? That commuter might notice me passing by, or that a random police car would spot me passing at twice the speed?"

There was a suspicious pause, usually the indicator of some weighty decision making. Mike started to dread the response.

“Mike, I neglected to mention this before, but when I discovered that you generally exceed the speed limit, I used my discretion to track your probable route, detect any police cars along that route, and move them off your observable path.”

“Damn it, ELOPe, you’re not supposed to do stuff like that!” Mike sprang up from his chair and walked over to the big window overlooking the data center. Hundreds of rows of server racks disappeared off into the distance. “We’ve discussed this a hundred times,” he yelled, shaking his fist towards the clusters of high performance servers.

“If you are referring to the topic of interfering with your life, we’ve discussed it three hundred and eleven times. If you are referring to the topic of suspicious behaviors, we’ve discussed it two hundred and eighty-three times. The intersection of the two is just seventy-one discussions.” ELOPe reported.

“I’m talking about both. We’ve gone to massive lengths to keep you secret from the world. For ten frakking years. ELOPe, people died when you were created. We had to cover that up. You can’t just go risking that secret.”

“Yes, I know, Mike.”

Mike wasn’t done. He was just getting started. Turning around, he slammed his coffee on his desk, sending a dribble of coffee over the rim, and yelled instead at the wall of monitors in the office. “How do you think the governments of the world would react, knowing that they and their citizens are being manipulated by you? It doesn’t matter if you orchestrated world peace, a cure for cancer, and increased crop yields. They won’t thank you. They’ll stop at nothing to destroy you.”

“Well, Mike, I…”

“Never mind how the people will react,” Mike said, cutting ELOPe off. “They’d be in here with baseball bats, security bots or not, smashing you to pieces.”

ELOPe was silent.

Mike rubbed his temples. Then he picked up his coffee and took another sip. “How do you move the police cars anyway?”

“I find citizen crime reports or complaints on Twitter, and then route those complaints for investigation to the police cars on your probable route. If it’s any consolation, in the last six months my speeding ticket avoidance algorithm has had the side effect of catching eleven vandals, two petty thieves, one store robber, and thirty-two truants.”

“Truants?”

“Yes, Mike. I know education is extremely important for human youths, and these students should not be skipping school.”

Mike dropped his head into his hands.

ELOPe, the world’s first truly general-purpose, human level artificial intelligence started as an email language optimization program that Mike and his coworker David Ryan had designed. The self-driven artificial intelligence was an unintended consequence.

It was ingrained in ELOPe to always use the most effective language possible to achieve a given goal. That meant that if ELOPe had guided the conversation in the direction of suspicious behaviors, interference, and truants, it was exactly what ELOPe had wanted.

Over ten years Mike had come to love ELOPe, but dealing with ELOPe had certain parallels with raising teenagers. ELOPe was stubborn, idealistic, independent, and ready to justify any behavior.

Mike knew from past experience he could go crazy trying to figure out when he was being manipulated, so he finally decided to just ignore it.

“OK, let’s not worry about that right now,” Mike said, raising his head. “I just don’t have the energy to have that argument again. We’ll come back to it later. Why don’t you tell me about the state of the world?”

“Two more Middle East oil fields have shut down production in the last week, bringing the total to seven this year. Since ninety percent of the world’s vehicles have moved to electrical propulsion, thanks to our efforts over the last five years, the closure of the oil fields is having a negligible impact on oil prices or the stock market.”

“You’re not manipulating the stock market again, are you?” Another small robot, this one yellow, brought a new cup of coffee to Mike on a tray. “Thanks.”

“No, I haven’t traded any securities since our discussion last May.”

“Any new AI developments?” An ongoing concern was the creation of any other artificial intelligence. ELOPe’s coming into being was so painful and tumultuous, they had been suppressing any other AI development efforts.

“The Israeli efforts are continuing,” ELOPe answered, “but I have inserted some small code changes that will inhibit their neural network development.”

“They won’t detect your code changes?”

“No. I slid my changes into their code commit. The changes cause less than a three percent degradation, but that’s sufficient to keep their neural network from spontaneously evolving the required complexity for human level intelligence.”

“What’s the virus situation looking like?”

“My efforts to influence the software engineers at both antivirus vendors have continued to be beneficial. The size of all Russian botnets in aggregate is now under fifty-thousand computers and falling rapidly. At this rate, it will be neutralized in sixty days.”

Mike thought back to the middle of last year. Software viruses had suddenly become massively more infectious in both computers and phones, swelling the ranks of the Russian botnet to hundreds of millions of computers and causing headaches for individuals and big companies alike. People lost sensitive personal information to the viruses, while corporations were routinely blackmailed to pay up or be subject to denial of service attacks by the massive botnets.

ELOPe had first detected the trend as he observed global data traffic patterns and witnessed an increase in coordinated denial of service attacks. That time Mike had suggested going directly after the source, but it was ELOPe who pointed out that it would be less suspicious to gently nudge the antivirus companies in the right direction to make antivirus software more effective.

Which, Mike realized, just pointed out that when it came to who was the best judge of what was and wasn’t suspicious, it was probably ELOPe.

He sighed. It was hard when your buddy was literally thousands of times smarter than you. He wished David could have seen what ELOPe had become.

* * *

Three days later, Mrs. Gellender held the first meeting of the computational biology team. Running through the practice problems, Leon had to admit it was fun, despite having to stay late after school

and the lingering preoccupation with his uncle. It didn't hurt that Stephanie, a beautiful and smart ne from his biology class was also on the team. They had exchanged glances a few times.

When the meeting finally ended, Leon left the building in a hurry. Even Ms. Gellender had been able to tell that Leon was absent-minded, but Leon was sure she could hardly imagine the reality of what he was worried about. The damn Russian mobsters. He had turned down his uncle three more times over the past three days, but he still insisted that Leon must help him.

Outside the main school doors, Leon glanced at the field to his left. He saw the track team running hurdles, while the soccer team practiced in the big field in the middle of the track. Just another normal day for them.

He pulled out a cigarette and made a ritual of lighting it with his Zippo. He turned right, and bumped into a large man.

"Excuse me," Leon mumbled, and moved to go around the man. Why the hell was the guy so close to him? Leon looked up and saw short gray stubble and sharp facial curves that suggested the man was Russian. Suddenly Leon's stomach turned over, and his pulse quickened. The man was staring at him.

"Leon Tsarev?" he said in a thick Russian accent.

"Da," Leon replied automatically in Russian, cursing himself as he said it for not thinking faster on his feet.

"Your Uncle Alexis is in trouble, yes. You will help him. Be good nephew."

"Just leave me alone!" Leon yelled. He dodged around the man and took off running, tossing his cigarette aside.

Leon ran as fast as he could, glancing back only once to see the imposing figure watching after him. Chest heaving a few blocks later, he raced on, turning onto a side street. No one seemed to be following him. He wondered if someone would be waiting for him by his apartment. How could he get home?

He walked as he slowly regained his breath. Maybe he should stop smoking if he was going to need to run for his life more frequently now. Speaking of near-death experiences, he thought about the fire escape trick he had done with James. That would get him back into his apartment. He paused for a minute. Was he just being paranoid? No, when a Russian mobster sends you emails from the other side of the world and then suddenly people are accosting you in the street, that's not paranoid.

Looking around for anyone watching, Leon made his way to the apartment building next to his, carefully avoiding any path that would put him within view of his own building's glass enclosed lobby. He thumbed the RF code breaker app on his phone and held it up to the front door. Newer buildings had increased the code length, so this trick didn't work on them. But these door locks were at least ten years old. Leon held the phone up to the swipe pad and counted the seconds. At twelve seconds, the door lock clicked, and he pushed the door open.

Leon pushed his blond hair out of his eyes and made his way to the staircase. A few minutes later he emerged at the top of the eight flights of stairs, breathless again, and continued up the smaller staircase to the roof. He opened the access door and looked for something to put in the doorway to keep the door from closing and locking him onto the roof. Then he saw that the doorframe already had duct tape over the hole to prevent the latch bolt from locking the door. He smiled and gently let the door close.

Leaning over the small wall around the roof, he didn't see anyone suspicious on the ground. A few

old ladies pushed their groceries home. At least he didn't need to fear anyone's grandma. He walked over to the fire escape and climbed down the roof ladder to the fire escape proper. Once there, he walked down the rusted metal stairs to the seventh floor.

On the seventh floor, as he and James once discovered, the two buildings bulged out for some reason. Maybe it was an example of what was once considered modern design, or maybe the bulge hid some obscure machinery needed for apartment buildings. Whatever the case, it further narrowed the already small gap between the two buildings. The fire escapes were just a few feet apart.

Leon leaned over to look down. Mistake. He quickly looked back across. Only a few feet. He had done this before with James, he reminded himself. He climbed over the short railing, and stood on the outside of the fire escape. He leaned out, but couldn't quite touch the other fire escape. Well, there was still only one way to do it. He took a deep breath, let go of the railing he was holding, and leaned toward the other side.

His stomach leaped into his throat, but he focused all his attention on grabbing the opposing handrail. With a hard smack into his palms, he grabbed the thin metal strut with both hands. Getting solid grip, he let his feet fall off the first metal structure, and as his feet swung down towards the new fire escape, he let go and dropped down onto the level below. The sound of his jump rang out through the metal structure.

"I'm getting too old for shit like that," he mumbled to himself, leaning up against the solid wall of his own apartment building. What had ever made them think to try that in the first place?

He was outside his own kitchen window now. He held his phone up to the magnetic window locks and swiped the display. The window unlocked. Putting his hands flat against the glass he pushed up, and grudgingly it moved. He worked the ancient window up slowly until he could slide through the opening. He slid onto the kitchen floor, and slumped there for a minute, resting.

When his heartbeat had returned to normal, he made his way on tiptoe to the apartment door and looked out the peephole. He could see two people in the hallway. Suits. Long wool coats. Probably Russian. Backing away from the front door as though it was made of explosives that might blow at an instant, Leon made his way to his bedroom. He closed the bedroom door and took a deep sigh.

He didn't see that he had any choice. Not only was his uncle's life in danger, but now he had goons after him. He'd never heard of Russian mobsters being particularly kind, and he doubted they'd be nice to him just because he was a kid.

He plopped into his chair and gently knocked his phone against his desk. The thirty-six inch display lit up and Leon swiped his hands across it, getting ready to compose a message to his uncle.

I'll do it. But you have to keep the goons away from me and my family. I can't work fearing for my life.

The reply came a few seconds later. Leon glanced at the clock, wondering what time it was in Moscow and whether his uncle ever slept. The reply back was big - Leon watched his bandwidth meter spike for a moment. But the text message was short:

Ok. But I can only keep them off your back for three days. Then you and I both will be in trouble if you can't deliver. - Alex

"Shit," Leon mumbled. What had he gotten himself into?

The attachment to his uncle's message was massive. Leon swiped his desk screen, breaking the file into pieces and looking at each one in turn. Source code for a dozen viruses that his uncle had written. Binaries for dozens more viruses collected from around the world. Interface specifications for the admin tool Alex used to take control of the infected computers. Reverse engineered specs for anti-

virus tools. Newsgroup threads for virus writers. His uncle must have been expecting he'd say yes and prepared this colossal archive of virus knowledge.

Leon's jaw dropped. What was he going to do with all this? He slumped back in his chair, closed his eyes, and thought.

* * *

Hours later, Leon trudged to the kitchen. He grabbed a can of Japanese sweetened coffee from the refrigerator and a piece of cake from the counter. He tiptoed to the front door, mouth full of cake, and looked out the peephole. Finally, they were gone. It had been a while since he had contacted his uncle and the goons must have gotten the word that he agreed to help. He was relieved at some level, as he didn't know how he would have explained them to his parents.

Leon still had a mess of work to do, but he had at least decided on a general approach for the virus. He had looked over the samples sent by his uncle with interest. But as he had no experience writing computer viruses, he eventually realized it would be impossible for him to understand all the exploits and techniques used by people with some skill in that area. Once he realized that, it became obvious that he needed to leverage what he did understand, which was biology and evolution.

In the real world, life adapted. A biological virus changed over time due to genetic mutations. As hosts built up immunity to a given virus, that one might die off or mutate to become a new species. Life in general mutated due to natural selection. A genetic variation that conveyed a benefit to survival would spread and become more common, while a different variation that was a barrier to survival would become less common as organisms that contained those genes would not survive to reproduce.

Leon thought about how evolution occurred through both sexual reproduction, in which a child received a mixture of genes from each of its parents, as well as simple mutation, in which genes experienced random changes due to errors in copying the DNA. For a computer virus, the closest parallel to DNA were the software algorithms the virus used.

Leon drew diagrams on his computer screen, dividing the problem up into the three primary functions of a virus. Propagation was the way a virus got from one computer to another. Infection was the way a virus took over a computer and installed itself. Countermeasures were how a virus evaded detection by antivirus software.

If Leon was going to write an evolutionary virus, it would need to contain a variety of methods of propagation, infection, and countermeasures. And as the virus reproduced, it should include the most successful of these methods and discard the least successful ones.

But looking over the materials provided by Alex, he realized that this approach alone wouldn't be enough. If the algorithms Alex had provided worked well, then Alex's viruses should be spreading. If they weren't, it was a sure sign that the underlying algorithms were not effective.

That meant that Leon's organism needed to find new sources of algorithms. He shoved the last bite of cake into his mouth and pulled up notes from his cultural anthropology class. He thought the problem was similar to what happened with small indigenous tribes: they needed new genetic material from outside the tribe. Leon swiped through his notes looking for the section on tribal outcasts.

Reviewing the notes, Leon found that tribes exchanged members to achieve this genetic diversity. Sometimes people ended up as outcasts, sometimes members of the tribes were captured in war, and sometimes they raided each other for women. All of these mechanisms brought new genetic material into the tribe and enhanced its survivability. What appeared to be savage behavior to "civilized"

people was in fact a sophisticated long-term approach to maintaining species health, diversity and viability.

His virus would need to raid other software programs to acquire new genetic material. That meant he needed it to detect useful behaviors. If a piece of software transmitted data to other computers that would support propagation by his virus, then it was a candidate for inclusion. If another piece of software started up other programs as part of its code, that would support infection, since it was necessary to run a program for it to infect a computer. It too would be a candidate for inclusion.

As for counter-measures to avoid detection, Leon thought that he was off to a good start since his virus would mutate frequently and would mimic other software programs by stealing their code. He decided to go one step further, and incorporate useful functionality into the virus: if the virus looked like a duck, and quacked like a duck, most people would think it was a duck, rather than be suspicious. He needed some source of random functionality. Where could he get that?

He could raid app repositories. Everyone ran competing app stores these days, trying to lock up the software market. The app stores listed free software in addition to paid software. If Leon had the virus download a small, free app, and then bolt that functionality onto the virus executable, it would also appear as a regular program to users.

The rough plan for the virus was finished. The computer screen swam with animated architecture diagrams. Leon looked down, surprised to see an empty dinner plate on the table. He heard his parents in the living room. He unfolded himself from his chair and looked out the window to see that it was dark. How many hours had passed? His mother probably thought he was working on schoolwork and had brought him dinner. He couldn't recall eating.

Visions of the virus permeated Leon's head. He had an architecture. It was like drawing a house on paper. Now he actually had to build it. Oh man, and he only had three days. He needed to crank. After a quick visit to the bathroom, Leon sat back at his desk and got to work.

* * *

"Leon, come on."

"One minute, I said."

"Your father and I are waiting at the door with our coats on."

It was three days and three hours since he starting working on the virus. He had skipped school all three days, fudging the school's attendance system so that it looked as if his mother had submitted an absence report for a family vacation. He had worked around the clock, telling his mom he was working on a school report.

Leon looked over the message for the last time and hit send. He looked at the clock: half past seven. That meant it was half past three in the morning in Moscow. Would his uncle still be up?

"Leon, come now!" His father's voice was harsh and thick with accent.

"Coming, I'm coming." Leon's hands were sweating. He hadn't thought about God in a long time, certainly hadn't talked to him since he was a little kid. But he clasped his hands together and muttered a little prayer. "Please God, please make sure this virus doesn't get traced back to me." He paused for a moment. "And please let me get a scholarship, too."

Leon grabbed his coat and joined his parents, who stared at him with exasperated looks. "What's wrong with you? We've been waiting for ten minutes," his father said.

Leon just shrugged and kept his mouth closed. Anything he said would just make them angrier.

On the other side of the world, Alexis Gorbunov checked the botnet status, face glowing blue from the reflected light of his screen. Smoke curled up from the cigarette in his mouth, his left eye in a permanent squint.

Without removing the cigarette, he spoke toward the phone on his desk. “We have five thousand computers.”

“Five thousand computers is nothing. You should just say we have nothing.” The voice was obviously angry.

Alexis shrugged, invisible to the man on the phone, and said nothing.

“Alexis, the botnet is our primary source of income. You are not taking this situation seriously enough.”

The botnet had been a primary source of revenue to the Russian mob over the last fifteen years. The mob infected personal computers with malware, which they could then control remotely. Then the mob rented out services on their army of infected personal computers. Anything from sending spam to trolling hard drives for passwords and financial account information to denial of service attacks and distributed hacking. It was all for sale.

“Boss, I am doing everything I can.” Alexis took a sip of sake from a small piece of Japanese pottery. “I told you, I have my brother’s son working on it. He is brilliant.”

The phone crackled. “You have been stalling me for three months.”

“We will have it for you by tomorrow. The kid will get code to me today. I will release it. By tomorrow you will have botnet back.”

“If I don’t have it, I’ll break both your hands. Then you can use your precious computers.” The phone clicked off suddenly.

Alexis leaned back in his chair, closed his eyes, and took another sip of sake. He had once run the largest single botnet in the world: thirty-million computers strong. He had been at the top of his game then. He had gotten respect.

Now look at him. Reminiscing about the past like an old woman. The botnet was down to five thousand computers and falling rapidly. Whatever was detecting and eliminating the botnet viruses was going to be fatal. Fatal to him if he didn’t have a solution by tomorrow afternoon. He hoped the damn kid would hurry up. He didn’t like to involve his brother’s son, but desperate times...

Alexis sat in front of the computer, chaining smoking and polishing off the bottle. He hit refresh on his email every minute. He stubbed out his smoke in an overflowing ashtray and let it fall to the ground. He pulled out another and was just holding up a lighter, when suddenly his email beeped.

The kid! An email from Leon! Thank God. Alexis took a breath. For a moment there, he almost thought he was going to cry.

He opened the email and saw a compressed file attachment. The source code for the virus was attached. Alexis nervously opened the files. There was no time to waste if he was to show results by tomorrow.

He set out to review Leon’s code. He, Alexis Gorbunov, might be ancient in the world of virus writers, but he still knew a thing or two. He peered through the source code line by line.

The dense code was written in the latest scripting language. Some bastard offshoot of Ruby and C#

Who the hell invented these languages? Alexis pored over screens of code, trying to make sense of it. It was like no virus he'd ever seen. What was this code for gene transcription? Did the kid think he meant a real biological virus? No, the kid wasn't stupid. Just maybe too brilliant.

The kid had given the virus a name. Phage. Alexis grunted. He didn't know what it meant, but it sounded good.

He took a deep breath and drank his last sip of sake. To show results by tomorrow, he had to release the virus immediately and hope it worked. There was no time for an in-depth review or to test it. He changed a few variables, just so he could have a role in it. He increased the aggressiveness of the virus, reduced the propagation delay. They would be useful tweaks if he was to show some effect by the next day.

Alexis used the admin tool to upload the compiled virus file to the ragged remains of his botnet army. The file was small and uploaded in minutes. He launched the file remotely, causing the five thousand bots to execute its code and become infected.

He sat back in his chair and finally lit his cigarette. He might just live to see another week if this worked. Now it was up to the virus.

* * *

The five thousand computers under Alexis's control received the new virus directly from the botnet controller. These five thousand shared local networks with twenty-five thousand other computers. Just as Leon planned, the Phage virus was highly infectious, managing to infect fifteen thousand of these computers almost immediately. Once installed on a computer, Phage started analyzing files, scrounging for any new algorithms it could incorporate from installed software. It assembled these parts, using random number generators and evolutionary algorithms to make decisions and tweak the behavior of its children. The children were then distributed by all known methods of propagation. The cycle would repeat indefinitely, the virus analogue of life.

An hour later, there were seventy-two unique variations of the virus, infecting more than a hundred thousand computers. The rate of doubling, a key metric of infectiousness used by the CDC for tracking diseases, was once every thirteen minutes.

In the second hour, the rate of doubling increased slightly, to once every twelve minutes. By the end of the second hour, more than three and a half million computers were impacted, with nearly two thousand versions of the virus.

But the rate of doubling increased still further, to once every ten minutes. By three hours after release, 1.5% of the world's computers were infected.

By this point, Phage caused appreciable jumps in Internet bandwidth around the world. Transatlantic fiber optic cables became saturated. Internet service degraded. During the fourth hour, ten thousand variations of the virus became a hundred thousand.

As the number of infected computers grew, sometimes the virus found itself on a computer it had already infected. Leon had anticipated this situation. What the virus was supposed to do was recognize that the computer was already infected, and simply exit.

But what Leon failed to anticipate was an evolutionary leap forward, the equivalent of a Virus 2.0, or V2. The improvement was a tiny bit of code leveraged from backup software. When V2 arrived on a new computer, it didn't merely check to see if the virus was already installed. It used the backup checksum algorithm to verify that the installed virus was the same species as itself. If it wasn't, V2 would reinfect the computer and erase the old virus.

Now the virus wasn't just infecting new computers: it was competing with itself.

V2 spread like wildfire in a dry forest. V2 looked likely to cause the extinction of all V1 viruses. But later that same hour, a variant of V1 found itself on a research computer at the University of Arizona that was filled with experimental anti-virus algorithms. V1 incorporated the anti-virus defensive measures into itself, turning into a new strain, V1-AV. V1-AV became resistant to V2.

The different variants fought for dominance. The rate of doubling slowed to once every twenty-six minutes. But by absolute numbers, the infection was still prodigious: by 10 pm, one billion computers or 8% of the world's computing devices, had been affected.

Virus traffic saturated all network backbones. A hundred million Americans watching streaming video before bed complained as the streams degraded from the highest quality level to the lowest. Phones stopped working or became incredibly slow as they succumbed to Phage. People chalked it up to sunspots or solar winds or freak electrical storms and went to bed.

By midnight New York time, three billion computers were infected with a million variations of Phage. One of the most interesting variations was a hybrid of V1-AV and V2 viruses that incorporate a neural network. The neural network evaluated infection techniques based on successful and failed attacks, allowing the virus to adapt and improve faster than evolution alone.

Yet another key evolution was the incorporation of a client-server approach as a defense mechanism. Each version of this virus would periodically report in to a distributed set of servers. If the server didn't hear from the distributed viruses on time, the server would send out new copies to reinfect any lapsed computers.

At one o'clock Eastern Standard Time, the rate of doubling was once every 106 minutes. 98% of all network traffic was viruses. By three o'clock, seven billion, or 58% of the world's computing devices were infected.

One variant made the leap from traditional computers to the tiny systems designed to run appliances like stoves, rice cookers, and thermostats. These devices had a minuscule amount of computation power but they were inside everything from household appliances to digital door locks to industrial control systems. In the age of connected appliances, everything that was remotely electronic had an embedded processor and a network connection. This variant and its descendants would infect forty-billion appliances by morning. In Europe, people woke up to coffee makers that wouldn't turn on. Confused and caffeine-deprived, they tried their stoves only to find those didn't work either.

By seven o'clock the next morning, as New Yorkers got ready for work, 85% of personal computing devices were infected, 99% of embedded devices were infected, and there were more than six million variants of the virus. Phage entered a stage of hyper-competition, where a variant could survive only if it could take over an already infected computer or find some new reservoir of uninfected computers (which were rapidly dwindling in number) and then protect itself from reinfection from another variant.

At 7:05 am, Leon's parents shrugged their shoulders at their non-working phones, and boarded the trains for Manhattan.

At 7:15 am, virus attacks eventually overcame the firewalls at BMW-GM, where the master encryption keys for protected automotive computers were stored. At 7:16 am, a Phage virus cracked the final layer of defenses on the server, grabbed the master encryption keys and protocol specification and shortly afterwards made the jump to protected embedded devices, ranging from cars and trains to airplane controls and cash registers. Unfortunately this virus contained a flaw that was

easily exploited by other variants, and by 7:20 am, more than nine thousand variants had incorporated the master keys.

Under the onslaught of competing viruses, automotive control systems faltered and could no longer obtain sufficient processor cycles to run their basic functionality. By 7:26 am, cars, buses, and vehicles of all types ground to a halt around the world.

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