Hacking the Nazis: The secret story of the women who broke Hitler's codes

By Nick Heath

Of the 10,000-plus staff at the Government Code and Cypher School during World War II, two-thirds were female. Three veteran servicewomen explain what life was like as part of the code-breaking operation during World War II.

"I was given one sentence, 'We are breaking German codes, end of story'."

as Ruth Bourne's first job out of college, when, like thousands of other young British women during World War II, she was recruited to aid the Allied cipher-breaking efforts at Bletchley Park.

Today, the mansion in the heart of the southeast English countryside is famous for being where the brilliant mathematician Alan Turing cracked the Nazi's Enigma code.

Because Turing's individual achievements were so momentous, it's sometimes forgotten that more than 10,000 other people worked at the Government Code and Cypher School, of whom more than two-thirds were female. These servicewomen played a pivotal role in an operation that decrypted millions of German messages and which is credited with significantly shortening the war.

The vital importance of preempting German plans led to a huge push to create machines that could crack ciphers at superhuman speeds. These efforts produced Colossus, the world's first programmable electronic digital computer.

However, the reality of running these electromechanical machines, setting rotors and plugging boards day in day out, was often less than thrilling, with the 18-year-old Bourne envying the girls who test-piloted aircraft fresh off the production line.

"That was exciting but standing in front of a machine for eight hours was not," she said.

Ruth Bourne, aged 18, wearing her Wrens uniform.
Image: Ruth Bourne

As mundane as her daily routine was, it was vital in deciphering coded messages sent by the German army, navy and air force and helping the Allied forces turn the tide of war.

The problem facing Britain and its allies early in the war was that the Enigma machine used to encrypt Nazi military traffic could scramble a message in 158 million million million ways, and each day the settings used would be changed. On top of that, on an average day at Bletchley Park code-breakers were tasked with breaking between 2,000 and 6,000 messages of German, Italian, Japanese and Chinese origin. There were far too many to check by hand.

The code-breaking needed to be automated, and it fell to British mathematician and father of the computer Alan Turing, with the help of the British Tabulating Machine Company, to devise the machine for the job.

His solution was the bombe, an electromechanical machine designed to emulate the workings of 36 Enigmas.

Bourne was a member of the Women's Royal Naval Service, known as the Wrens, who were charged with preparing the machines each day, turning the drums on the front and plugging up the boards at the back according to settings laid out in a menu. These settings were derived from cribs, which were best guesses at fragments of plain text—for example, standard openings such as weather reports—from the enciphered messages.

If correct, these cribs would reveal some of the Enigma settings used to encode the message and provide a starting point for devising the remaining settings. The bombe could check the possible ways the Enigma could have been set up incredibly rapidly, dismissing incorrect settings one at a time.

If the crib and initial settings were good, then the bombe could return the information needed to crack the code within minutes.

"I joined just around D-Day and at that time the traffic was tremendous. We were breaking thousands of messages," Bourne said.

"We knew that every 24 hours the code was changed and that was why time and accuracy were of the absolute essence. You were really pressured."

Like Bourne, many of the Navy Wrens operating the bombes were teenagers not long out of school, who found themselves working a punishing schedule, with very little margin for error.

Bourne said, "You didn't have to be rocket scientists but what you had to be was 125 percent accurate. You worked in pairs and you and your checker would plug up the back of your machine, which was extremely complicated. You had to brush out the wires on your drums so there wouldn't be short circuits, make sure the plugs at the back of the machine were pushed in and straight, and you had to be on the go for the eight-hour shift, as you you were standing for the whole time."

There was little respite during a shift for the bombe operators, even during meal times.

"You had half an hour off for a meal," said Bourne. "The bombes were in a building with high brick walls, barbed wire and sentries, you had to get out from there, run to your canteen, grab your meal and run back and then your checker, who'd been operating while you were away, could go and get her meal. It was very intense and very concentrated. We were young and learned quickly."

The manor house at Bletchley Park as it appears today.
Image: shaunarmstrong/mubsta.com

The high-point of the day was getting a "Job Up" message, as it meant that their machine had broken a code, but she was always conscious one mistake could wreck their chances.

Bourne said, "You were a link in the chain and you couldn't be the weakest link. If you'd made a mistake on your machine—you hadn't pushed a drum on properly or you'd put a plug in incorrectly—and the machine wouldn't work, you would get a reprimand, 'If you had been more accurate, we might have brought the job up'."

Adding to the stress were the working conditions. Bombe operators worked round the clock, with teams spending one week working 8am to 4pm, the next 4pm until midnight and then midnight to 8am after that.

"The main pressure was the changing of the shifts, because you were always jetlagged. Your body clock was all over the place. I found it very hard to sleep during the daytime as there were not really proper blackout curtains, they were very flimsy and thin," said Bourne.

Outside this serious work, however, Bourne and her fellow Wrens were pretty normal teenagers, with similar preoccupations to those of young people today.

"We had two lives really," Bourne said. "One where you were in your workstation and you knew your bombe machine was ticking over and you brought a job up. But outside that it was being a normal girly in the Wrens. 'Who were you dating tonight? Where have you been? Are you going dancing in Covent Garden?' That kind of thing."

SEE: The undercover war on your internet secrets: How online surveillance cracked our trust in the web (http://www.techrepublic.com/article/the-undercover-war-on-your-internet-secrets-how-online-surveillance-cracked-our-trust-in-the-web/)

Inside the code-breaking factory

If an Enigma code was broken early in the day, then the Allied forces would be able to decipher all messages sent by that arm of the military in the area until the Enigma settings were changed at midnight.

But that didn't mean the bombes were switched off, there were always new intercepts and new messages to unscramble.

"The bombes never stopped. I think we broke two and a half million messages during the war," she said.

The code-breaking operation was spread over teams working in various huts around the manor house at Bletchley, with the bombe machines situated in outstations nearby. There were about 8,000 people involved in the code-breaking—what was known as the factory—and 4,000 support staff. Each team generally knew no more than was necessary about what the other groups were doing.

Teams worked in different huts on breaking the Enigma codes, focusing on the army and air-force ciphers in one and the tougher naval encryption in another. Unscrambled messages were then sent on to linguists for translation and officials who would decide how the information should be used and, more importantly, whether it could be used without revealing that the Allies had cracked Enigma.

Often, stopping the Germans from discovering Enigma was not secure meant contriving an alternative way the Allied forces could have discovered sensitive information, such as where in Germany petrol was being sent from to Erwin Rommel's tank divisions in North Africa.

"We would send our reconnaissance planes up but in fact we knew where the petrol was because we'd decrypted messages about it," Bourne said.

"But if we couldn't find another way, if there was no subterfuge, we couldn't use the information."

Given the significance of the work taking place at Bletchley, it's easy to think it would be a difficult secret to keep. But it is only later in life that Bourne learned how important a role she played.
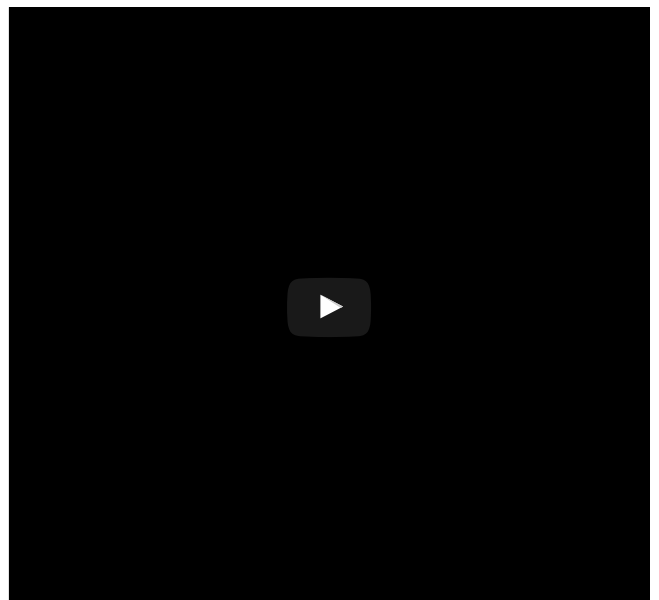
"It may have been more difficult for other people than it was for me because I knew so little. I knew we were breaking German codes but other people would know we've just managed to win the Battle of [Cape] Matapan or we've just managed to sink the Scharnhorst," said Bourne. "However, everybody knew that everybody was doing the same thing in terms of breaking German codes, and that is why, when you signed the Official Secrets Act, you never told anybody. My parents died and never knew what I was doing."

At the end of the war the order came in from Winston Churchill to take apart the more than 200 bombes that had been built, and Bourne found herself destroying the machines she had spent so long working with.

"We were told to dismantle all of these wonderful bombe machines. We had to unsolder contacts from wires and put them into separate boxes and they were sold off eventually as army surplus."

In the years that followed, the Enigma cipher was still used by certain countries and Britain probably wanted these countries to continue thinking their communications were secure.

"It's thought that Churchill didn't want people to know we had that technology because he probably foretold the Cold War," she said. "I know for a fact that two of them were kept at Eastcote [one of Bletchley's outstations]. One of them was a three-wheel bombe and the other a four-wheel bombe for the naval codes."

Celebrating Bletchley's veterans

All these years later, Bourne is still operating a bombe machine. The machine is the only working bombe in the world and used in demonstrations at Bletchley Park. It took about 13 years to rebuild and sits in the on-site centre that tells the story of the park's wartime activities.
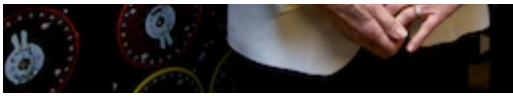
Ruth Bourne at Hut 11 in 2013.
shaunarmstrong/mubsta.com

Bourne is grateful that the work of the World War II code-breakers has so much recognition today, after years of being overlooked. Millions of pounds in funding from the National Lottery has allowed the huts around Bletchley Park to be restored and a visitor centre created. In 2009 the government also presented Bourne and other surviving Bletchley veterans with a commemorative badge emblazoned with, "We also served".

This support was a long time coming, with decades passing when the work done at Bletchley was shrouded in secrecy or ignored.

"Even the minister for veterans had said we didn't deserve anything, not even a certificate or a little badge to put on our war medal. We were just nothing and nobody," said Bourne.

"Now we have recognition in spades, we have a memorial and we've had visits from almost every member of the royal family. I've demoed the Enigma to the Queen and Prince Philip, which was very personally satisfying. You can't do more than that, can you?"

That interest in the code-breakers' story should only be heightened by the recent release of *The Imitation Game*, the Oscar-nominated movie telling the story of Alan Turing and his role in creating the bombe.

For the 88-year-old Bourne, the days spent setting up the bombes and watching them whir and click into life seem a far cry from the mundane work she felt it to be as a teenager.

"Now, when I'm an old women, it's exciting," she said. "Now I know how important it was."

The listener

Patricia Davies spent World War II listening - spending hours at a time trying to pick voices from squealing static.

Patricia Davies served at various listening
stations.
Image: Patricia Davies

Even when Davies heard a person, the chances are they wouldn't be speaking anything resembling a human language but robotically reciting gobbledygook one letter at a time.

Davies was one of a room full of women scouring the radio waves and scribbling down these nonsensical monologues. From where she sat in a lonely, clifftop house overlooking the English Channel she could see the sun glinting off car windscreens in Nazi-occupied France.

These messages weren't intended for Davies but were orders destined for German submarine bases on the west coast of France or ships in the Baltic Sea.

The seemingly random jumble of letters were a code produced by the Enigma machine, which took the German messages and scrambled the letters in quintillions of different ways.

Davies was a member of the Wrens who were capturing these communications and sending them by teleprinter to the codebreakers at Bletchley Park, or Station-X as they called it.

"We would sit at a bench with a row of radio receivers on it and we would twiddle the knob up and down the frequencies the German navy used," said Davies.

"It obviously required good hearing and intense concentration. I was 19 when I started and at that sort of age your hearing is good and you're used to concentrating on things," Davies said. "It was an immensely satisfactory job, particularly when you were getting a clear message and you knew it was important."

While picking out a message was particularly rewarding, the four hour shifts could equally be fruitless.

"The hardest part was the frustration when you knew there was a ship sending out a message and you were trying to get it but it was distorted or fading.

— PATRICIA DAVIES

"You could often have a watch in which nothing would come up. You would sit there looking up and down [the radio frequency] and not get any traffic," she said. "The hardest part was the frustration when you knew there was a ship sending out a message and you were trying to get it but it was distorted or fading."

Davies said, "It was very frustrating when you could only send a patchy message to Bletchley. We would get through anything we had but they weren't always complete."

Even when messages were garbled, accuracy remained paramount. The German operators spoke four phonetic letters at a time and if you missed something you would never guess at what they said.

"If you didn't hear some things, through interference or fading, you left a blank. Whatever you did, you didn't invent," Davies said.

German orders weren't just spoken but also sent as Morse code, and the series of long and short beeps the Germans used to open these messages stay with the 91-year-old Davies to this day.

"They had an administrative code that all ships used for heading and signing off," said Davies. "That always began with three letter groups, beginning with the letter Q, dar-dar-de-dar-de-dar-de-de-dar."

SEE: Enterprise encryption: Trends, strategic needs, and best practices (http://www.techproresearch.com/article/enterprise-encryption-trends-strategic-needs-and-best-practices/) (Tech Pro Research)

Under fire

From the listening station near Dover, Davies had a sometimes harrowing view of British convoys running the gauntlet of German artillery shells as they travelled along the English Channel.

"The Germans used to shell quite a lot," she said. "It was called Hellfire Corner because they used to try to hit the convoys that slipped past on the coast going west."

"They used to go past as a line of ships and, one time, one of the shells got a direct hit. We saw the ship explode and catch fire. Nobody got off it. It drifted out and the rest of the convoy just went on with a gap in it. We all felt very sad that day," she said.

> "The Germans used to shell quite a lot. It was called Hellfire Corner because they used to try to hit the convoys that slipped past on the coast going west.

— **PATRICIA DAVIES**

Even though the shelling and V1 rockets damaged the nearby port of Dover, the Germans didn't think to attack the non-descript house on the clifftops where Davies worked.

"We were lucky because even though we were in range the Germans didn't actually hit our building," Davies said. "The only shell that came into our watchroom didn't actually explode. It was the time of the V1s, the doodlebugs, which started about 10 days after D-Day, and used to come over our cliff in absolute shoals."

"The grimmest place"

What sticks in Davies mind, more so than V1 rockets flying overhead, were the handful of days she spent at a station that was trying to pinpoint the location of German U-boats. The Nazis used the submarines to sink merchant ships travelling from the US to the UK in an attempt to starve Britain of supplies and equipment.

"It was in the Spring of 1943, when there were a great many sinking of convoys in the Atlantic," Davies said.

On the rare occasion these U-boats came to the surface to communicate with their base they could be located using direction finding. The technique allows radio operators to determine where a signal was sent from by comparing differences in how that signal is received by antennas in varied locations.

"There was a very large listening station under Scarborough race course where they were only listening for U-boats. They didn't often surface and speak and if they did then

everybody had to hold their breath while direction finding stations around the country tried to get a fix on that U-boat," she said.

"I think that was quite the grimmest place I ever was in the war. You were aware this U-boat had probably got its sights on ships in a convoy that might be sunk in the next few minutes. I felt the importance of the job there, even more than at Dover where there were shells and V1s coming over."

Besides feeding codebreakers intercepts, the station also eavesdropped on uncoded messages about German operations and tipped off British forces to give them the jump on the enemy.

Davies said, "They used to send their torpedo boats over to the east coast to attack our convoys and lay mines. They would send messages 'There's an English destroyer at this many degrees', things like that. [There was] no way that was coded because they wouldn't have had time. Those messages didn't go to Bletchley, they went to the nearest naval base."

Similarly, indiscreet messages between lighthouse keepers off the French coast helped alert the British to the movements of the German navy.

"One of my colleagues picked up a message from one lighthouse keeper to another saying 'Look out in an hour and you will see something interesting', which was actually the Scharnhorst and Gneisenau, which were two German battleships, that were going to go up the channel," she said.

During time serving at a different listening station, at Withernsea in Yorkshire, Davies even remembers stumbling across messages from a distant theatre of the world war, carried by radio waves that had bounced off the earth's ionosphere (http://en.wikipedia.org/wiki/Skywave) giving them intercontinental range.

Looking back today Patricia Davies fondly remembers simple acts of kindness.
Image: Patricia Davies

"We even accidentally picked up radio signals that didn't seem to fit into the German naval pattern," she said. "It turned out they were German tanks on the Russian front talking to each

other. It was, of course, of no interest, but was rather eerie."

Amid the serious work there was time for fun. Davies still has a photo of her with her fellow Wrens practicing their tap dancing steps and has fond memories of bike rides and horse riding nearby, as well as the occasional party at the Royal Air Force fighter stations.

But it is the simple acts of kindness that stick in Davies mind, like the solace of being handed a mug of hot chocolate at the start of a 4am shift.

"Someone would come and wake you in your nice warm bunk at 3.30am to go on watch. That is an awful time to start work and it was a great comfort if they'd thought of making you a mug of cocoa when you got to the watchroom," she said.

Like the other veterans, Davies is delighted by the public recognition the Bletchley codebreakers have received, as reflected by the rising visitor numbers to the museum at the park.

But she said the work done at the tens of Allied listening posts - known as Y-stations (http://en.wikipedia.org/wiki/Y-stations) - to intercept the hundreds of thousands of confidential Nazi communications also deserves credit.

"It wasn't just our coastal naval stations, there were a great many listening stations all sending their traffic to Bletchley. Very seldom does anybody ask what we did at the outstations. If they weren't getting our messages they wouldn't have had anything to decode."

The Colossus operator

1944 was a landmark year for Irene Dixon.

The east London teenager from a terraced house with an outside toilet not only found herself living in an 18-century mansion on a 3,000-acre estate but she had just landed a job working on one of the world's first computers.

The machine was the Colossus—the world's first programmable electronic computer—which, unknown to Dixon, would allow the Allied forces to read messages sent between Hitler and his military leaders - sometimes before the generals themselves had laid eyes on them.

Those early days working at Bletchley Park made an impression on the young Dixon, particularly her accommodation in the nearby stately home of Woburn Abbey.

"To me it was incredible, I lived in East Ham in a little terraced house with no bathroom and a tiny garden," she said.

Irene Dixon was billeted at the stately
Woburn Abbey.
Image: Irene Dixon

"Our lives changed immediately, the whole of Woburn Abbey grounds were our garden as such."

The work she would do was no less remarkable, particularly in its impact on the outcome of the World War II.

The Colossus would lay bare the intentions of highest echelons of the Nazi command and was the culmination of years of work to crack the Lorenz cipher used by Hitler and his lieutenants.

Designed to supplant the unreliable Heath Robinson and replace unwieldy analogue components with digital equivalents, the Colossus was one of the world's most complicated pieces of calculating equipment at the time of its invention. It was data processing writ large, with information wrangled by 1,500 glowing hot valves spread over a machine that stood taller than most men.

Dixon was a member of the Women's Royal Naval Service and despite being posted inland, she and her comrades maintained the illusion of being at sea, referring to Woburn Abbey as a ship, the bedrooms as cabins and saying they were 'coming ashore' when they departed to work at Bletchley.

Soon after the Colossus' arrival at Bletchley in 1944, Dixon found herself working next to the men who helped create the field of computing. Sitting alongside her as she flipped switches on the Colossus and loaded reels of tape were the likes of British mathematician Max

Newman—who helped produce the world's first stored program electronic computer—and Jack Good, the cryptanalyst who later worked alongside Alan Turing on another of the earliest computers, the Manchester Mark I.

"We took our orders from the cryptanalysts, who were incredibly intelligent people. They would sit by us, I can visualise them now. They had a little table, a chair and their slide rules and they would tell us what settings to use, based on probability theory," she said.

As celebrated as those individuals are today for helping shorten the war, attitudes towards them at the time were a good deal harsher.

"They were working at Bletchley and people would say 'It's alright for them, they've got themselves into a safe job straight from university', so life wasn't easy for them," Dixon said.

"My husband that was out on the Normandy beaches got a medal but these people got nothing."

Hacking Hitler

In the years before Colossus was built, Bletchley codebreakers manually broke Lorenz-enciphered messages used by Hitler and his inner circle. The breakthrough came when cryptanalysts realised the settings the Lorenz SZ machine used to encrypt messages weren't entirely random. By using complex statistical analysis they worked out they could calculate the starting point of each of the Lorenz machine's 12-pin wheels and in doing so decipher Lorenz codes.

Colossus performed this analysis at blistering speed compared to a human mathematician - able to decipher messages in hours rather than weeks - as it was able to read messages punched onto paper tape at a rate of 5,000 characters per second.

"The machine never ever stopped working from that day."

— IRENE DIXON

The clanking of an automatic typewriter attached to the Colossus, which would type settings that had a high probability of being correct, was always a welcome sound for Dixon.

"That was exciting, it was a happy noise when you heard that clonk, clonking away. You were on your way then to breaking the wheel settings."

As with Enigma-enciphered messages, once Colossus had determined the wheel settings every Lorenz-enciphered message from that region could be cracked.

With the development of the Mark II Colossus—deployed just in advance of the D-Day landings—messages could be read even faster, at a rate of 25,000 characters per second. The machine's speed was thanks to various innovations by inventor Tommy Flowers, including the addition of a logic circuit that we today would call a shift register (http://en.wikipedia.org/wiki/Shift_register).

From the moment of the machine's introduction to the end of World War II the Colossi were engaged in round the clock codebreaking.

"We worked in eight hour shifts testing different settings. There were always new messages. They were coming through thick, the people at Knockholt [listening station] were sending messages through all the time," Dixon said.

"The machine never ever stopped working from that day [it was turned on]."

SEE: **Photos: The life of Alan Turing** (http://www.techrepublic.com/pictures/photos-the-life-of-alan-turing/1/)

Hands-on with the first computer

To Dixon the room-sized machine was something of a mystery and she admits being oblivious that the contraption that towered over her was one of the world's first computers.

"It was an enormous machine and we just accepted it I suppose. This was what we were going to work on," she said.

"Nobody explained it had just been invented. We didn't know that they just said: 'This is what you're going to work on and this is what it does'."
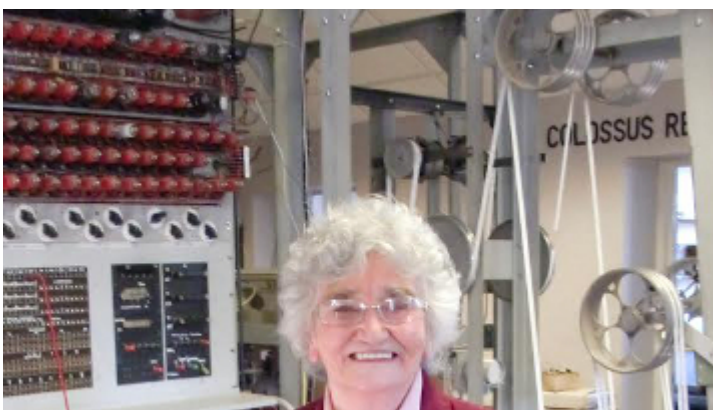
Irene Dixon with The National Museum of
Computing's Colossus.
Image: Irene Dixon

Ten versions of the Colossus were built but by 1960, in order to keep the machine's existence secret, all had been dismantled and all drawings of the machine were burnt - so the machine didn't have a direct impact on the development of future computers.

However Turing was aware of the Colossus, and went on to draw up the plans for the Automatic Computing Engine or ACE, whose capabilities were a step beyond those of Colossus, in that it was a stored-program and general-purpose computer.

Given Colossus' legacy, Dixon said its inventor, British Post Office engineer Tommy Flowers, should be a household name.

"The concept of computing has changed the world. To me every school child should know of Tommy Flowers," said Dixon.

"He came from nearby where I lived and came from an ordinary background, his father was a bricklayer. If only children knew that they too, if they worked, could be a Tommy Flowers."

Despite being there at year zero for computing, it is only decades later when she is in her 90s that Dixon has begun using computers.

"I worked on the world's first computer and never looked at one since. My husband has got an iPad, so I'm learning a bit about that in my old age," she said.

When the war ended Dixon spent another year in the navy, helping take weather observations for the service in Scotland, before returning to her job with the consumer goods giant Unilever.

"I went back to the same office, the same firm, the same house and nobody knew what I'd done in those three years," said Dixon.

"You just forgot all about it actually, it's very strange. I wasn't until 1996 when I had been to Bletchley Park that it all came alive to me again."

Like her fellow veterans Dixon kept her wartime activities secret for decades and says her silence was made easier by how little she knew about what she did.

"If I'd known that I'd been working on messages from Hitler's high command I would have found it very difficult not to have told my parents," she said.

"In fact, I'm glad my father didn't know, he would have probably have told people I won the war."

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Nick Heath is chief reporter for TechRepublic. He writes about the technology that IT decision makers need to know about, and the latest happenings in the European tech scene.

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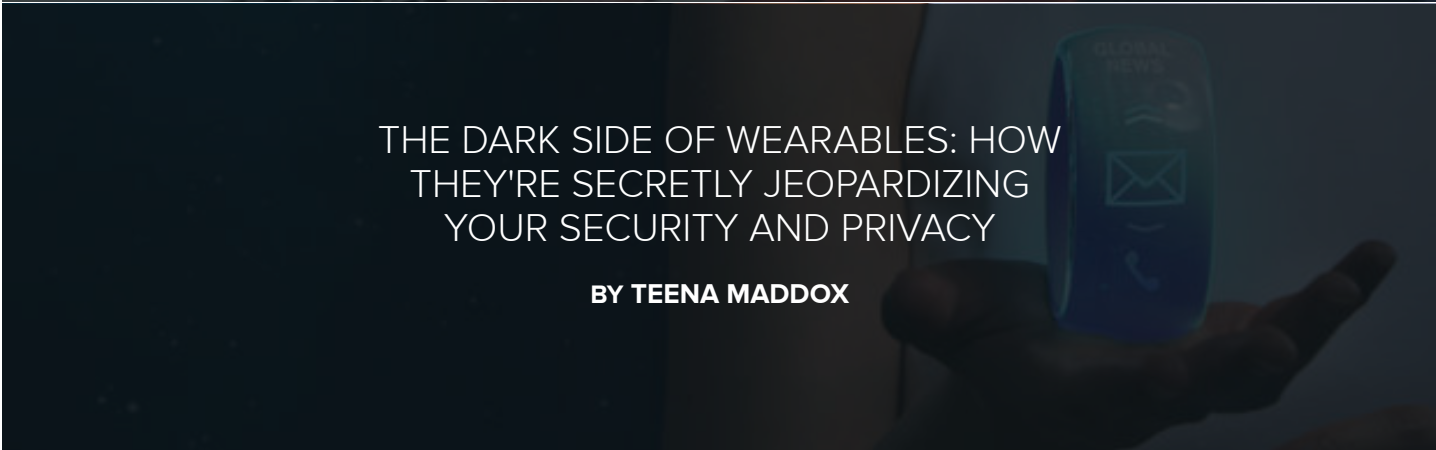
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