computers are bad

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Previously on Deep Space Nine, I wrote that "the mid-2000s were an unsettled time in mobile computing." Today, I want to share a little example. Over the last few weeks, for various personal reasons, I have been doing a lot of reading about embedded operating systems and ISAs for embedded computing. Things like the NXP TriMedia (Harvard architecture!) and pSOS+ (ran on TriMedia!). As tends to happen, I kept coming across references to a device that stuck in my memory: the TacNet Tracker. It prominently features on Wikipedia's list of applications for the popular VxWorks real-time operating system.

It's also an interesting case study in the mid-2000s field of mobile computing, especially within academia (or at least the Department of Energy). You see, "mobile computing" used to be treated as a field of study, a subdiscipline within computer science. Mobile devices imposed practical constraints, and they invited more sophisticated models of communication and synchronization than were used with fixed equipment. I took a class on mobile computing in my undergraduate, although it was already feeling dated at the time.

Today, with the ubiquity of smartphones, "mobile computing" is sort of the normal kind. Perhaps future computer science students will be treated to a slightly rusty elective in "immobile computing." The kinds of strange techniques you use when you aren't constrained by battery capacity. Busy loop to blink the cursor!

Sometime around 2004, Sandia National Laboratory's 6452 started work on the TacNet Tracker. The goal: to develop a portable computer device that could be used to exchange real-time information between individuals in a field environment. A presentation states that an original goal of the project was to use COTS (commercial, off-the-shelf) hardware, but it was found to be infeasible. Considering the state of the mobile computing market in 2004, this isn't surprising. It's not necessarily that there weren't mobile devices available; if anything, the opposite. There were companies popping up with various tablets fairly regularly, and then dropping them two years later. You can find any number of Windows XP tablets; but the government needed something that could be supported long-term. That perhaps explains the "Life-cycle limitations" bullet point the presentation wields against COTS options.

The only products with long-term traction were select phones and PDAs like the iPaq and Axim. Even this market collapsed almost immediately with the release of the iPhone, although Sandia engineers wouldn't have known that would come. Still, the capabilities and expandability of these devices were probably too limited for the Tracker's features. There's a reason all those Windows XP tablets existed. They weighed ten pounds, but they were beefy enough to run the data entry applications that were the major application of commercial mobile computing at the time.

The TacNet Tracker, though, was designed to fit in a pocket and to incorporate geospatial features. Armed with a Tracker, you could see the real-time location of other Tracker users on a map. You could even annotate the map, marking points and lines, and share these annotations with others. This is all very mundane today! At the time, though, it was an obvious and yet fairly complex application for a mobile device.

The first question, of course, is of architecture. The Tracker was built around the XScale PXA270 SoC. XScale, remember, was Intel's marketing name for their ARMv5 chips manufactured during the first half of the '00s. ARM was far less common back then, but was already emerging as a leader in power-efficient devices. The PXA270 was an early processor to feature speed-stepping, decreasing its clock speed when under low load to conserve power.

The PXA270 was attached to 64MB of SDRAM and 32MB of flash. It supported more storage on CompactFlash, had an integrated video adapter, and a set of UARTs that, in the Tracker, would support a serial interface, a GPS receiver, and Bluetooth.

A rechargeable Li-Poly pack allowed the Tracker to operate for "about 4 hours," but the presentation promises 8–12 hours in the future. Battery life was a huge challenge in this era. It probably took about as long to charge as it did to discharge, too. There hadn't been much development in high-rate embedded battery chargers yet.

The next challenge was communication. 802.11 WiFi was achieving popularity by this time, but suffered from a difficult and power-intensive association process even more than it does today. Besides, in mobile applications like those the Tracker was intended for, conventional WiFi's requirement for network infrastructure was impractical. Instead, Sandia turned to Motorola. The Tracker used a PCMCIA WMC6300 Pocket PC MEA modem. MEA stands for "Mesh Enabled Architecture," which seems to have been the period term for something Motorola later rebranded as MOTOMESH.

Marketed primarily for municipal network and public safety applications, MOTOMESH is a vaguely 802.11-adjacent proprietary radio protocol that provides broadband mesh routing. One of the most compelling features of MEA and MOTOMESH is its flexibility: MOTOMESH modems will connect to fixed infrastructure nodes under central management, but they can also connect directly to each other, forming ad-hoc networks between adjacent devices. 802.11 itself was conceptually capable of the same, but in practice, the higher-level software to support this kind of use never really emerged. Motorola offered a complete software suite for MOTOMESH, though, and for no less than Windows CE.

Yes, it really enforces the period vibes that the user manual for the WMC6300 modem starts by guiding you through using Microsoft ActiveSync to transfer the software to an HP iPaq. One did not simply put files onto a mobile device at the time; you had to sync them. Microsoft tried to stamp out an ecosystem of proprietary mobile device sync protocols with ActiveSync. Ultimately none of them would really see much use, PDAs were always fairly niche.

Sandia validated performance of the Tracker's MEA modem using an Elektrobit Propsim C2. I saw one of these at auction once (possibly the same one!), and sort of wish I'd bid on it. It's a chunky desktop device with a set of RF ports and the ability to simulate a wide variety of different radio paths between those ports, introducing phenomena like noise, fading, and multipath that will be observed in the real world. The results are impressive: in a simulated hilly environment, Trackers could exchange a 1MB test image in just 13.6 seconds. Remember that next time you are frustrated by LTE; we really take what we have today for granted.

But what of the software? Well, the Tracker ran VxWorks. Actually, that's how I ran into it: it seems that Wind River (developer of VxWorks) published a whitepaper about the Tracker, which made it onto a list of featured applications, which was the source a Wikipedia editor used to flesh out the article. Unfortunately I can't find the original whitepaper, only dead links to it. I'm sure it would have been a fun read.

VxWorks is a real-time operating system mostly used in embedded applications. It supports a variety of architectures, provides a sophisticated process scheduler with options for hard real-time and opportunistic workloads, offers network, peripheral bus, and file system

support, and even a POSIX-compliant userspace. It remains very popular for real-time control applications today, although I don't think you'd find many UI-intensive devices like the Tracker running it. A GUI framework is actually a fairly new feature.

The main application for the Tracker was a map, with real-time location and annotation features. It seems that a virtual whiteboard and instant messaging application were also developed. A charmingly cyberpunk Bluetooth wrist-mounted display was pondered, although I don't think it was actually made.

But what was it actually for?

Well, federal R&D laboratories have a tendency to start a project for one application and then try to shop it around to others, so the materials Sandia published present a somewhat mixed message. A conference presentation suggests it could be used to monitor the health of soldiers in-theater (an extremely frequent justification for grants in mobile computing research!), for situational awareness among security or rescue forces, or for remote control of weapons systems.

I think a hint comes, though, from the only concrete US government application I can find documented: in 2008, Sandia delivered the TacNet Tracker system to the DoE Office of Secure Transportation (OST). OST is responsible for the over-road transportation of nuclear weapons and nuclear materials in the United States. Put simply, they operate a fleet of armored trucks and accompanying security escorts. There is a fairly long history, back to at least the '70s, of Sandia developing advanced radio communications systems for use by OST convoys. Many of these radio systems seemed ahead of their time or at least state of the art, but they often failed to gain much traction outside of DoE. Perhaps this relates to DoE culture, perhaps to the extent to which private contractors have captured military purchasing.

Consider, for example, that Sandia developed a fairly sophisticated digital HF system for communication between OST convoys and control centers. It seemed rather more advanced than the military's ALE solution, but a decade or so later OST dropped it and went to using ALE like everyone else (likely for interoperability with the large HF ALE networks operated by the FBI and CBP for domestic security use, although at some point the DoE itself also procured its own ALE network). A whole little branch of digital HF technology that just sort of fizzled out in the nuclear weapons complex. There's a lot of things like that, it's what you get when you put an enormous R&D capability into a particularly insular and secretive part of the executive branch.

Sandia clearly hoped to find other applications for the system. A 2008 Sandia physical security manual for nuclear installations recommends that security forces consider the TacNet Tracker as a situational awareness solution. It was pitched for several military applications. It's a little hard to tell because the name "TacNet" is a little too obvious, but it doesn't seem that the Sandia device ever gained traction in the military.

As it does with many technical developments that don't go very far, Sandia licensed the technology out. A company called Homeland Integrated Security Systems (HISS) bought it, a very typical name for a company that sells licensed government technology. HISS partnered with a UK-based company called Arcom to manufacture the TacNet Tracker as a commercial product, and marketed it to everyone from the military to search and rescue teams.

HISS must have found that the most popular application of the Tracker was asset tracking. It makes sense, the Tracker device itself lacked a display, under the assumption that it would be in a dock or used with an accessory body-worn display. By the late 2000s, HISS had rebranded the TacNet Tracker as the CyberTracker, and re-engineered it around a Motorola iDEN board. I doubt they actually did much engineering on this product, it seems to have been pretty much an

off-the-shelf Motorola iDEN radio that HISS just integrated into their tracking platform. It was advertised as a deterrent to automotive theft and a way to track hijacked school buses in real time---the Chowchilla kidnapping was mentioned.

And that's the curve of millennial mobile computing: a cutting-edge R&D project around special-purpose national security requirements, pitched as a general purpose tactical device, licensed to a private partner, turned into yet another commodity anti-theft tracker. Like if LoJack had started out for nuclear weapons. Just a little story about telecommunications history.

Sandia applied for a patent on the Tracker in 2009, so it's probably still in force (ask a patent attorney). HISS went through a couple of restructurings but, as far as I can tell, no longer exists. The same goes for Arcom, a company by the same name that makes cable TV diagnostic equipment seems to be unrelated. Like the OLPC again, all that is left of the Tracker is a surprising number of used units for sale. I'm not sure who ever used the commercial version, but they sure turn up on eBay. I bought one, of course. It'll make a good paperweight.