Re-envisioning the STATPack™

S. McGrath, MS; G. Hoff, MS, MBA; A. Fruhling, Ph.D
UNO College of Information Science & Technology | Public Health Informatics Laboratory

Abstract

Rural areas in the US have been increasingly underserved due to a shortage of physicians. STATPack™ (Secure Telecommunications Application Terminal Package) was built to help address some of the diagnostic limitations in these underserved areas. STATPack™ enables secure remote communication and diagnosis of microbial infections. The system includes both macroscopic and microscope imaging capabilities, to enable diagnosis of a variety of pathogens. These same limitations of medical access face NASA astronauts. It isn't possible or practical to provide astronauts a full wet lab traditionally used for diagnostics work. In this project we evaluated methods for adapting the STATPack™ system for use in spaceflight and for diagnostic purposes on extended trips, such as a mission to Mars. A review of the literature was performed to investigate the current state of telemedicine in space. That information was used in building the foundation of our case for two NASA grants, Human Exploration Research Opportunities (HERO) and Experimental Program to Stimulate Competitive Research (EPSCoR). Both grants target the need to address medical issues astronauts may encounter during missions. A plan was developed for methods to miniaturize the STATPack™ system, explore ways to add wireless components, and adapt its control to a tablet interface.

Introduction to STATPack

STATPack™ is an emergency response system that addresses critical health information and biosecurity needs. The STATPack™ system application is a secure, dedicated, HIPAA compliant, web-based network system that supports telecommunication connectivity of clinical health laboratories. The system architecture uses client/server technology and operates in a distributed environment. This connectivity allows for immediate communication and data transfer of urgent health information by transmitting images and text.

Medical Challenges in Space

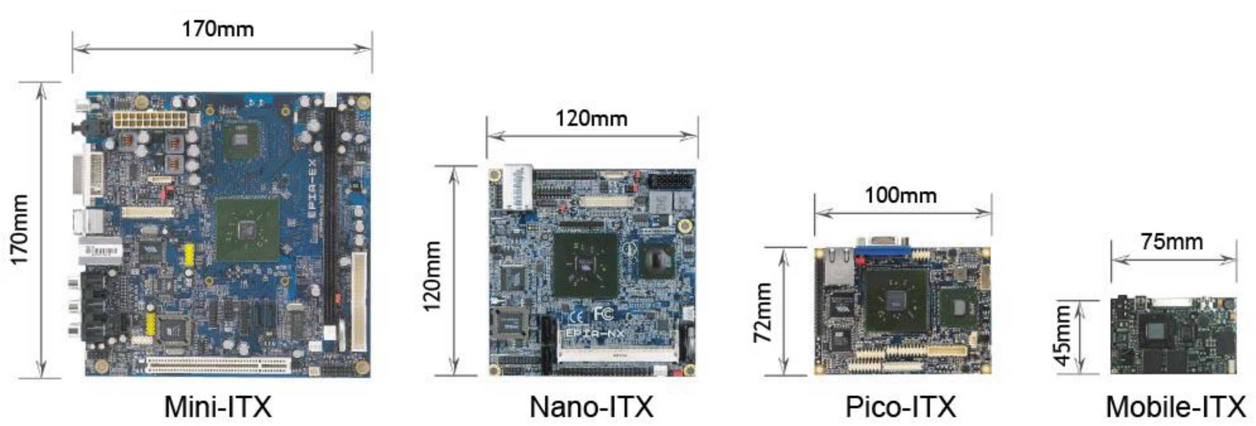
Planning a manned space flight to Mars and other explorations requiring extended periods in space are faced with a daunting problem. The environmental conditions for that trip are both difficult to fully anticipate and hard to develop counter-measures for.

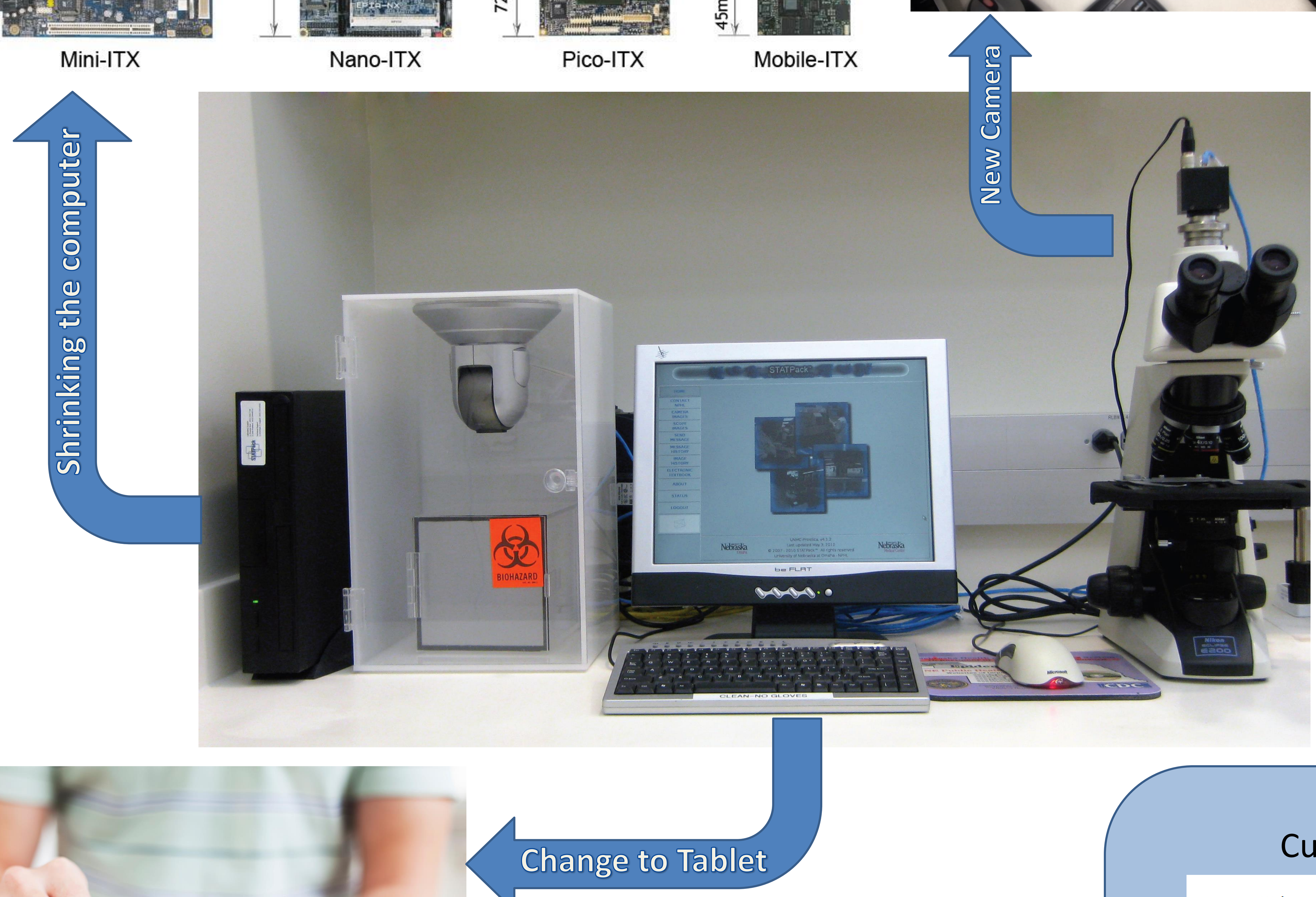
Challenges (cont)

What is known is that microgravity and high-energy, ionizing comic rays (HZE) nuclei pose severe health implication for any human on a Mars bound ship [1]. The decreased gravity environment of a space flight impacts every organ in the body to some degree. Body fluid shifts, cardiovascular changes, muscle atrophy, neurovestibular changes, and bone demineralization are all immediate health concerns following space flight [2]. Long term concerns from increased cosmic ray exposure can yield an increased cancer risk and development of early cataracts [3,4]. A third major concern for human space travel is the apparent impact it has on the immune system, or immune dysregulation [2,5]. It has been shown that post space flight, astronaut's neutrophils, monocytes, and NK-Cells all display decreased functionality [6, 7, 8]. In addition, T-Cell activation, altered levels of immunoglobulins, and latent viral reactivation among other maladies all have been linked to space flight [9].

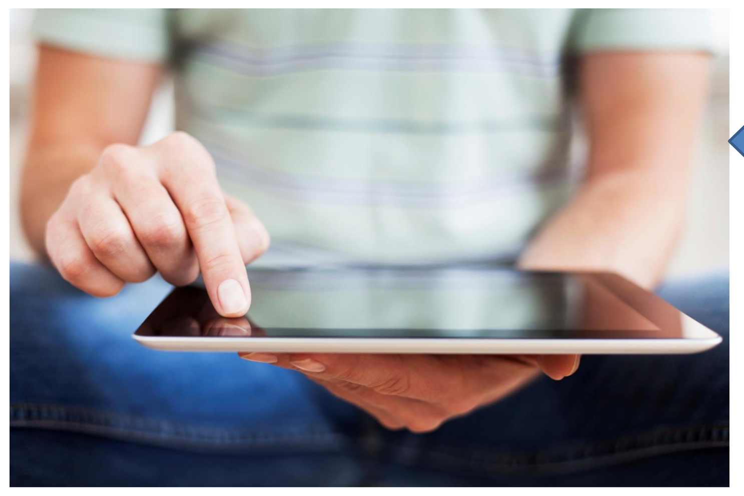
Challenges (cont)

All of this data and knowledge has been derived from the astronauts after their missions in space. Conditions in space can be mimicked, but not exactly replicated. This has lead to the call for in-flight data collection performed during actual long-duration space flight in addition to in-flight medical instrumentation [10, 11, 12].Telemedicine is uniquely equipped to address this need. Devices built for space telemedicine have a specific set of requirements and hurdles to overcome. As the targeted range of human space flight increases, communication latency becomes more of an issue [13]. To resolve this problem, telemedicine devices should focus on providing real time data that is accessible on-board, have high bandwidth capacity with store-and-forward capabilities, support wireless technology, and be able to establish "relay" satellites to minimize data interruption [9].






Sample Image



Current Progress

In order to adapt the STATPack™ for space flight three principal goals were established:

1. Miniaturize the system
    - Move from mini-ATX to Mobile ITX
    - Move to a modular approach over a fully connected system
2. Add wireless components
    - Adapt a GoPro camera in place of the hardwired camera
3. Tablet interface
    - Move beyond a PC based interface to one that can be controlled via tablet.

Grant Support

This project partially funded through the NASA Nebraska Space Grant

References

1. Setlow, R. B. (2003). The hazards of space travel. *EMBO reports, 4*(11), 1013
2. Williams, D., Kuipers, A., Mukai, C., & Thirsk, R. (2009). Acclimation during space flight: effects on human physiology. *Canadian Medical Association Journal, 180*(13), 1317-1323.
3. Cucinotta, F. A., & Durante, M. (2006). Cancer risk from exposure to galactic cosmic rays: implications for space exploration by human beings. *The lancet oncology, 7*(5), 431-435.
4. Cucinotta, F. A., Schimmerling, W., Wilson, J. W., Peterson, L. E., Badhwar, G. D., Saganti, P. B., & Dicello, J. F. (2009). Space radiation cancer risks and uncertainties for Mars missions.
5. Crucian, B., & Sams, C. (2009). Immune system dysregulation during spaceflight: clinical risk for exploration-class missions. *Journal of leukocyte biology, 86*(5), 1017-1018.
6. Kaur, I., Simons, E. R., Castro, V. A., Mark Ott, C., & Pierson, D. L. (2004). Changes in neutrophil functions in astronauts. *Brain, behavior, and immunity, 18*(5), 443-450.
7. Kaur, I., Simons, E. R., Castro, V. A., Ott, C. M., & Pierson, D. L. (2005). Changes in monocyte functions of astronauts. *Brain, behavior, and immunity, 19*(6), 547-554.
8. Mehta, S. K., Kaur, I., Grimm, E. A., Smid, C., Feeback, D. L., & Pierson, D. L. (2001). Decreased non-MHC-restricted (CD56+) killer cell cytotoxicity after spaceflight. *Journal of Applied Physiology, 91*(4), 1814-1818.
9. Williams, D. R., Bashshur, R. L., Pool, S. L., Doarn, C. R., Merrell, R. C., & Logan, J. S. (2000). A strategic vision for telemedicine and medical informatics in space flight. *Telemedicine Journal and e-Health, 6*(4), 441-448
10. Crucian, B. E., Stowe, R. P., Pierson, D. L., & Sams, C. F. (2008). Immune system dysregulation following short-vs long-duration spaceflight. *Aviation, space, and environmental medicine, 79*(9), 835-843.
11. Nicogossian, A. E., & Williams, R. S. (2010). Medical Care for a Mars Transit Mission and Extended Stay on the Martian Surface. *Journal of Cosmology, 12*, 3758-3767.
12. Sams, C. F. (2013). The Human in Space: Lesson from ISS.
13. Williams, D. R., & Turnock, M. (2011). Human Space Exploration The Next Fifty years. *McGill Journal of Medicine: MJM, 13*(2).