

SLIPSTREAM APPLIANCE: NGS EDITION

MIT's Ed DeLong Sifts Microbial Treasure Troves Using SlipStream



Deciphering how marine microbial communities influence the world's energy and carbon budgets is the province of [Ed DeLong¹](#), prominent metagenomics researcher at MIT and member of the National Academy of Sciences. Few scientists match DeLong's animated eloquence when discussing the quest to understand lowly microbial "bugs" – a pursuit that today depends heavily on next generation sequencing (NGS), powerful computational tools, and submersible robots able to roam the sea.

DeLong artistically describes the challenge of bringing microbial genomics to the general public in a recent *Environmental Microbiology Reports* publication (*Microbial Earth: the motion picture*²). He says "...Imagine you win the lottery and your prize is to travel with Sir David Frederick Attenborough to train in the art of crafting popular Nature documentaries. In your travels with the master, you are awed by the raw violence of great whites devouring sea lions, by the smooth stealth of a hunting lioness, by the speed and grace of the gazelle that evades her, and by the unimaginable diversity of plant and animal life in the rainforests and coral reefs."

[How] are you going to connect in the same emotional, visceral and intuitive ways as Attenborough [when describing the microbial world]? Will you show the savagery of exoenzyme hydrolysis attacking a dying diatom bloom, the grace and beauty of runs and tumbles in a chemotactic sensory path, the vicious jab of a Type III pilus, or complex food chain dynamics that recycle carbon and energy between microbes and sediments?"

The vivid picture he paints is arresting. It is also quite important as the exchange of energy mediated by the vast microbial world may turn out to be decisive in maintaining life on earth. To conduct his research, DeLong and his colleagues have had to invent new robotic sampling techniques, deploy NGS technology, and recently purchased Bioteam's SlipStream Appliance: NGS Edition to handle data management and analysis necessary to glean insight from the data flood.



SlipStream NGS is a device that is preloaded with BioTeam's MiniLIMS data management software and Galaxy³, a comprehensive data analysis platform. SlipStream NGS is a natural complement to a desktop sequencing instrument. It provides a powerful, self-contained IT infrastructure, optimized for handling large NGS datasets, but configured to maximize ease-of-use and minimize IT support requirements.

"Sequencing is so much easier now approaching trivial really, and information management has become the bottleneck. A device that centralizes those functions

with respect to data archives, storage, and analysis is a tremendous aid," says DeLong. His lab obtained SlipStream NGS to help manage data from their Illumina Miseq.

"Because our samples sometimes come from diverse environments we carefully track all of the metadata as well as the massive amounts of sequencing data. Using MiniLIMS we are able to easily define our own metadata fields and standardize them. That information can be interfaced with the MiSeq sample sheets and directly helps us prepare the sample sheets for use in sequencing runs," says DeLong.

Samples are then run through NGS instruments in the lab. SlipStream NGS is used to manage data and to identify the many species (eukaryotic and bacterial) present, the genes being expressed, interactions between the various species present, and changing environmental conditions.

"We're able to capture freeze frames over time for the whole community's gene expression and are able to recapitulate things for some organism back in the lab. For instance, particular types of phytoplankton have really beautiful diurnal cycles and rhythms (patterns of gene expression) that happen over the course of the day and we can see those in these wild, mixed populations of these organisms," says DeLong.

"I like to call it a day in the life of these bugs. But there are many utilitarian aspects as well. For example people like to think about them as sensors and building biosensors if you will, and that is a worthy goal, but my take is the biosensors are already out there and we just need to read their outputs."

Adopting and adapting new technology is *de rigueur* at the DeLong lab. One challenge, for example, was finding a way to sample microbes at various depths and in moving currents in such a manner as to preserve gene expression profile at the time of sampling. DeLong and colleagues developed a technique using submersible robotic labs that able to sample marine microbes *in situ*, break open the cells quickly, and 'fix' the transcriptome (e.g. RNA fragments) that spill out of the cells – all long before being brought back onto research vessels.⁴

DeLong's research has already produced impressive findings.

“Using these metagenomics approaches we discovered whole new mechanisms that marine organisms use to get energy from sunlight,” says DeLong. “The amazing thing is these mechanisms are not rare. Almost every microbe it turns out – if they are not using the kind of standard chlorophyll-based photosynthesis – have these other photo proteins they are using to trap energy from sunlight and its routinely common but nobody knew it.”

According to DeLong, the biggest advantages of the SlipStream appliance are its ease-of-use and compute power. “Typically if you are trying to run a compute cluster and you have other storage devices and your sequencer, you are running multiple different operating systems which entails a lot of IT management overhead. Because SlipStream is an all-in-one device, it's much easier to manage. We're able to run jobs directly on SlipStream that previously would have to run on the MIT cluster.”

For more information about the SlipStream Appliance please visit www.bioteam.net/slipstream

NOTES

¹Morton and Claire Goulder Professor, Department of Civil and Environmental Engineering and Department of Biological Engineering, MIT; Member, National Academy of Sciences <http://cee.mit.edu/delong>

²Microbial Earth: the motion picture, Society for Applied Microbiology and Blackwell Publishing Ltd, *Environmental Microbiology Reports*, 5, 1–16, http://eddelong.mit.edu/publications/assets/Crystal_Ball_redux_2013_emi412021.pdf

³The Galaxy Project, <http://galaxyproject.org>; *Galaxy* is an open, web-based platform for data intensive biomedical research. Whether on this free public server or [your own instance](#), you can perform, reproduce, and share complete analyses. The [Galaxy team](#) is a part of [BX at Penn State](#), and the [Biology](#) and [Mathematics and Computer Science](#) departments at [Emory University](#). The [Galaxy Project](#) is supported in part by [NSF](#), [NHGRI](#), [The Huck Institutes of the Life Sciences](#), [The Institute for CyberScience at Penn State](#), and [Emory University](#).

⁴Metatranscriptomics reveal differences in *in situ* energy and nitrogen metabolism among hydrothermal vent snail symbionts, *ISME Journal* advance online publication, 25 April 2013, <http://eddelong.mit.edu>

BOX1 - SlipStream NGS Edition SPECS

SOFTWARE AND TOOLS	
MiniLIMS	Flexible data management software, including source code (www.bioteam.net/minilims)
MiniLIMS Instrument Plug-in	1 sequencer plug-in (Additional sequencer plug-ins available for purchase)
Galaxy	Production configuration of Galaxy
Galaxy Tools	Assembly, annotation, variant calling, and other analysis tools accessible through the default Galaxy interface
Galaxy Datasets	Human, mouse, the <i>D. Melanogaster</i> , <i>C. elegans</i> , and <i>S. cerevisiae</i> . Additional datasets may be available upon request
HARDWARE	
CPU	2x Intel® Xeon® Processor E5-2690, 8 core (16 cores total)
Memory	12x 32GB RDIMM (384GB) Optional Upgrade to 512GB
Storage	7x 3TB SAS 6 Gbps HDD (16 TB usable) 1x 100GB Solid State Disk
Power	Dual Redundant Power Supplies
Network	Dual Gigabit Network Adaptor
SUPPORT	
Installation	Includes setup
Training	User and developer training included
Customization	5 days of customization services to facilitate instrument integration included
Warranty	Includes 1-year hardware warranty
Annual Support Options (Additional)	MiniLIMS upgrades + basic support Galaxy and tools upgrades + basic support Premium Galaxy support
Consulting Services (Additional)	Includes workflow customization, process automation, software and systems integration, and more