KanseiGenie Infrastructure Catalog

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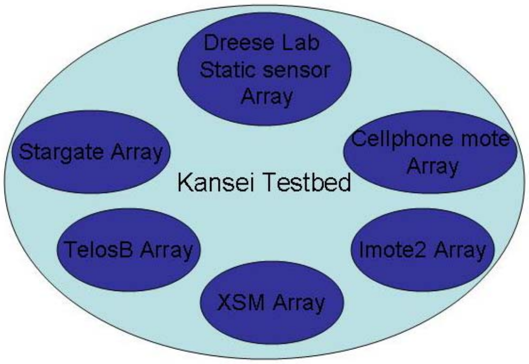
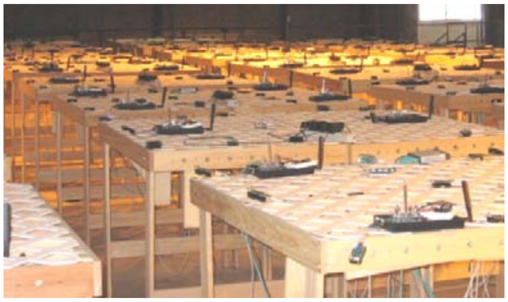
1. Provide an overview of the hardware systems in your contribution.

Kansei is an infrastructure facility for wireless sensor network experimentation with high fidelity. Its hardware-software infrastructure supports convenient local and remote at-scale testing on a variety of sensor platforms deployed in diverse environments. The Kansei project is headed by Professor Anish Arora.



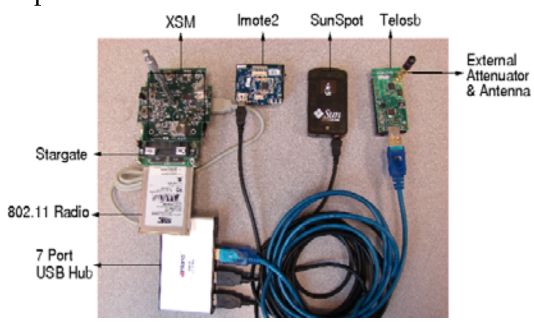
Located in the Ohio State campus, Kansei spans two deployments. One deployment is in an indoor, but open, warehouse setting with 8500 sq. ft. Here there are 4 types of sensor mote arrays:

- 112 Extreme Scale Motes (XSM)
- 432 TelosB motes
- 112 iMote2, and
- 112 Extreme Scale Stargates (XSS) that serve as micro servers.



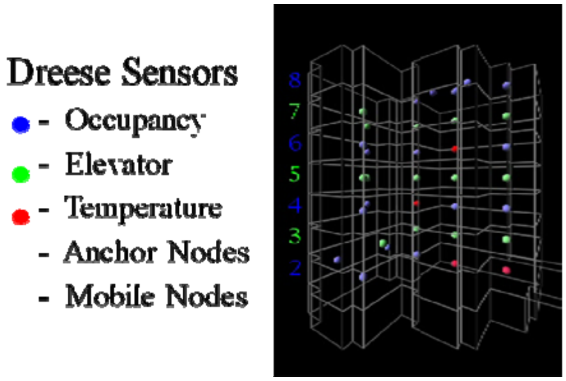
All of the arrays are organized in a grid which is deployed approximately 3 feet off the ground, by using an array of wooden tables. The configuration of the grid is as follows.

- The Stargates are organized in a 14*8 grid.
- To each Stargate, one XSM is connected through a 52-pin serial port.
- To each XSS, 4 TelosB motes and 1 iMote2 mote are connected through a USB hub.
- The Stargates are connected using both 100 Mbps wired and 802.11b wireless Ethernet. Through the wired network, all Stargates are connected to a central server which provides various services and tools for users.



The warehouse arrays of Kansei provide a testbed infrastructure to conduct experiments with 802.11b networking as well as different 802.15.4 radios installed on XSMs, TelosBs and iMote2s. We have access to iMote2s which .NET capable, as well as SunSPOT motes which are Java capable, but these have yet to be integrated with the testbed infrastructure.

The second Kansei deployment is in the Dreese Laboratories building occupied by the Computer Science Department. In the false ceiling of each floor of this 8 storey building, 30 TelosB motes are placed. Application specific TelosB and other sensors communicate with this array of nodes.



The Dreese fabric also includes 35 Cellphone-Mote pairs which form a peer to peer network. Unlike the TelosB array, this array is at present not remotely programmable.

As a part of the Kansei consortium, the NetEye testbed is a high fidelity testbed which provides a controlled indoor environment with a set of sensor nodes and wireless nodes deployed in Wayne State University. The physical NetEye substrate consists of an expandable collection of building block components. The set of components that will be integrated with Kansei and GENI include 130 TelosB motes with light sensors. The NetEye project is headed by Prof. Hongwei Zhang.

2. *Discuss the GENI resources offered by your substrate contribution, and how they are shared, programmed, and/or configured. Include in this discussion to what extent you believe the shared resources can be isolated.*

Kansei allows slices to be granted on one or more of the arrays —Stargates, XSM, TelosB, IMote2—that comprise its substrate.

The following is a list of the resources that are available on each type of node:

- A Stargate is equipped with 400MHz PXA55 XScale processor capable of running Linux, 64 Mb RAM and 32MB flash. It also contains a 10/100 Ethernet NIC, 802.11b NIC, RS-232 Serial, and one USB port.
- An XSM has a 4 MHz, an 8 Bit CPU, 128 KB instruction memory and 4KB RAM. For communication, the mote uses a 916MHz low-power single channel radio capable of delivering 10 KB/sec of raw bandwidth. The radio's range is between 10 and 25 feet. It is thus identical to the Mica2 as a node platform, but differs in that it has a variety of sensors and actuators including a magnetometer, a microphone, four passive infrared receivers, a photocell, a sounder, and feedback LEDs. XSMs were designed specifically for the ExScal project by The Ohio State University, the University of California at Berkeley, and CrossBow Technology, and were manufactured by CrossBow Technology.
- A TelosB mote is an IEEE 802.15.4 compliant device that is manufactured by Crossbow Inc. It has a T1 MSP430 microcontroller, 2.4 GHz Chipcon CC2420 radio, 4 MHz 8 bit CPU, 128kB instruction memory, and 4KB RAM.
- An Imote2 (IPR2400) is an advanced wireless sensor node platform with a

CPU and memory at a micro-level yet with a sensor mote energy footprint. It is built around the low-power PXA271 XScale processor, running at 14 to 416 MHz and integrates an802.15.4 radio (CC2420) with a built-in 2.4GHz antenna. It contains 56kB SRAM, 32MB FLASH and 32MB SDRAM. Each iMote2 is connected to a stargate individually through a USB hub connected to the USB port of the stargate.

Kansei allows any OS that has been ported to the mote platforms to be loaded on that mote. In the past, a significant percentage of the experiments have chosen TinyOS for the motes.

Since conventional mote operating systems do not support multi-threading efficiently, typically, each slice requests a number of “full nodes” today. (We fully expect this situation to change in the future.)

Configuration and code-deployment on the slices is performed via the Ethernet network to the Stargates, and as need be though the serial port of the Stargate onto the XSM, and the USB port to the TelosB or Imote2. We note that a part of the Stargates resources are reserved for managing the XSMs and Tmotes.

Kansei provides isolation to concurrent experiments through a couple of techniques. Through its scheduling service, it offers the option that no concurrent job runs on the same type of array. In terms of radio interference, users can choose different frequencies for their experiments to achieve radio band isolation. However, Kansei can only guarantees compile-time isolation of radio interference at the moment. Since radio frequencies used by sensor nodes can be changed at run-time, we need further techniques to improve radio isolation.

NetEye consists of a fixed array of wireless and sensor nodes. The wireless nodes are Dell Vostro 1400 laptops with the Intel dual core processor, 1GB RAM and 80GB hard drives. These 15 laptops are placed on the top of 15 wood benches deployed in a 3×5 grid. (Note: the laptops are supporting TelosBs, and they are not designed to run GENI experiments in Spiral 1.)

NetEye has 130 TelosB motes which are connected to the aforementioned laptops through USB2.0 interface. 6-12 motes are connected to each laptop.

3. ***Provide an overview of the physical connections within the substrate aggregate, as well as between the aggregate and the GENI backbones. Identify to the extent possible, non-GENI equipment, services and networks involved in these connections.***

The connections between the motes and the Stargates and central Kansei servers have been detailed above.

The Kansei servers can be connected to the OSCnet, a state-of-art internet backbone network (with bandwidths higher than Internet2 backbones) in the state of Ohio.

OSCnet ties-in in to the Internet 2.

In NetEye, the motes are connected to laptops through USB interface, and the laptops are connected to the NetEye server via Ethernet. The NetEye server will be connected to the WSU campus network, via which the NetEye server (and the NetEye substrate) will be connected to the Internet2 backbone through Merit Networks. *There may be a cost associated with the Internet2 connection.*

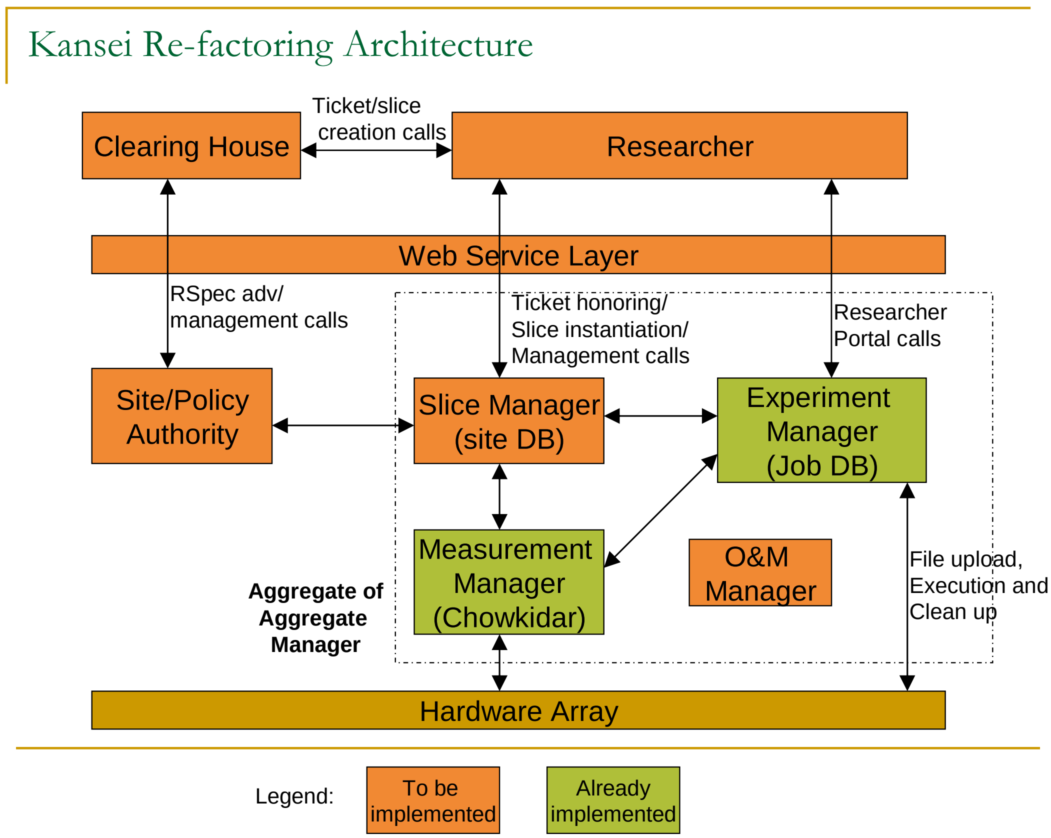
4. Identify the physical connections and software interfaces for integration into your cluster's assigned control framework

The Kansei Server acts as the interface between the Kansei substrates and GENI backbone. The Kansei Server is connected to the OSU campus network, which is part of the state-wide OSCnet. OSCnet ties-in into the Internet 2 at Cleveland, OH.

The interface between NetEye and the GENI backbone is the NetEye server. The NetEye server will be connected to the WSU campus network, via which the NetEye server (and the NetEye substrate) will be connected to the Internet2 backbone through Merit Networks.

Both Kansei Server and NetEye Server will expose API as web services for scheduling, deploying and interacting experiments on the substrates.

Previously, Kansei had implemented its own control framework. In cooperation with the GENI project, we now plan to use the ORCA control framework to integrate with rest of the GENI framework. The refactored KanseiGenie architecture is shown below. Specifically, the ClearingHouse will be accommodated into ORCA. Detailed software interfaces are available from our Kansei Genie Wiki at http://sites.google.com/site/siefastgeni/documents-1 .



5. Identify any measurement capabilities, either embedded in your substrate components or as dedicated external test equipment.

The Kansei health management service, called 'Kansei Doctor', is an autonomous health service, periodically measures the number of available nodes, their health, radio link quality and other networking metrics relevant for sensor networks. Kansei also provides storage space for users to log their custom experimental data, and it has user interaction services such as data/command injection.

NetEye will use the Kansei health services/tools. We plan to develop a number of new tools to measure different environmental factor for sensor networks. NetEye provides storage space for users to log their experimental data, and user interaction services just as Kansei does.

Any tools developed in future will be used by both NetEye and Kansei.

6. Describe any tools or services which may be available to users and unique to your substrate contribution.

Kansei and NetEye provide a web portal for local or remote users to easily access the testbed. Using the current web-interface an authorized user can create slices, schedule a job on the testbed to automatically program the sensor and wireless devices on a particular slice and store the experimental data on the server. Kansei supports scripted, real time data and event injection. The Kansei health monitoring service called the 'Kansei Doctor' is an autonomous self-contained health monitoring system which can be requested to run along with an experiment to monitor the job in real-time. Kansei and NetEye supports scripted, real time data and event injection.

The entire set of health monitoring and data injection services will be available for users. Apart from that we plan to develop online user interaction services called 'dash-board' services which are unique to our substrate, will be available for users.

The resource scheduling mechanism that we plan to implement can also ensure a fair share of resources to its users and allow a dynamic request of resources from its users.