

**KanseiGenie:**  
***GENI-fying and Federating***  
***Autonomous Kansei Wireless Sensor Networks***

**Final Report**

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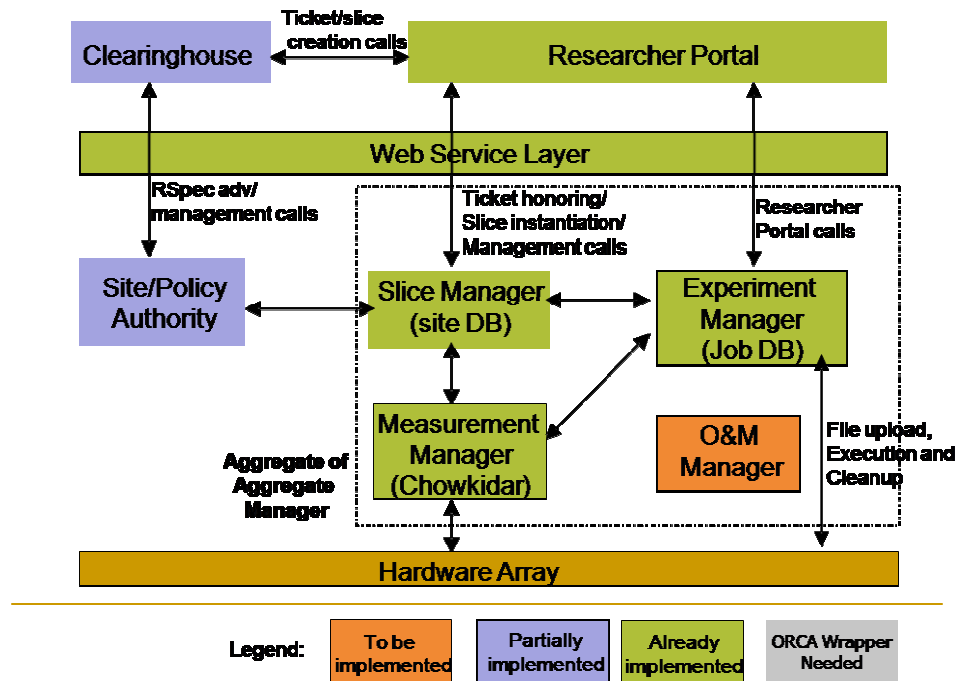
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## 1. Major accomplishments

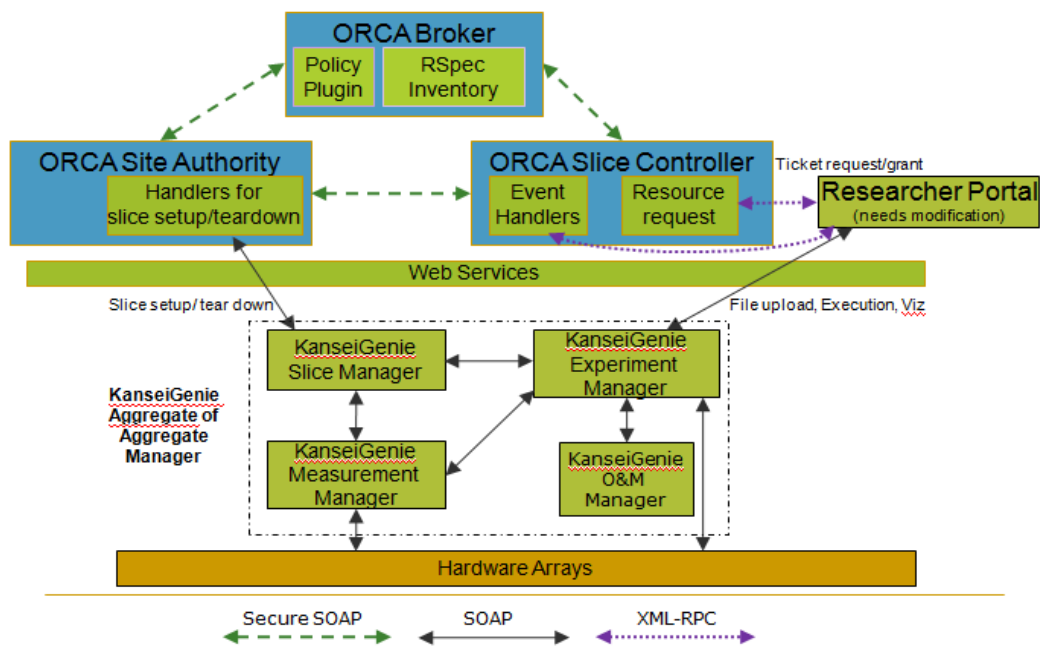
- Refactored KanseiGenie architecture according GENI principles, architecture, and APIs

### KanseiGenie Architecture



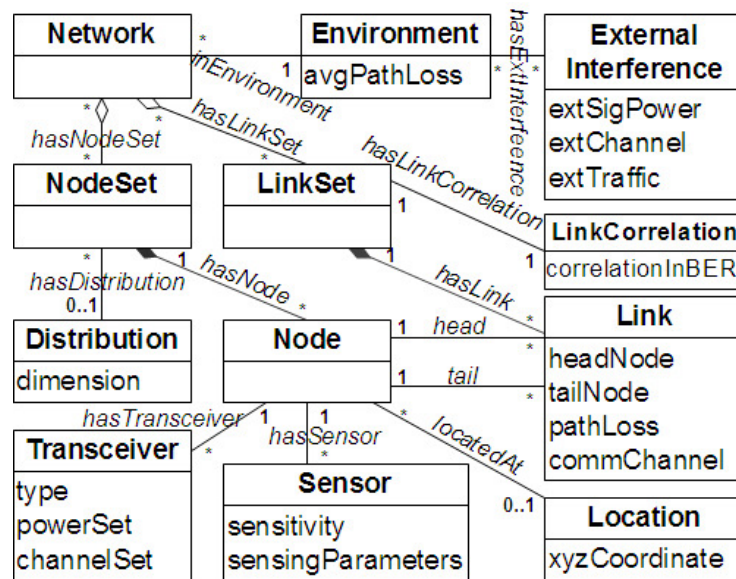
- Refactored Kansei web interface into Researcher Portal
- Genified (most) Kansei user services as web services, e.g. implemented (some of the) experiment interaction interfaces as web services
- Genified Kansei scheduler
- Genified CM/AM aspects of Experiment & Slice Management planes

- Integrated KanseiGenie with the ORCA control framework

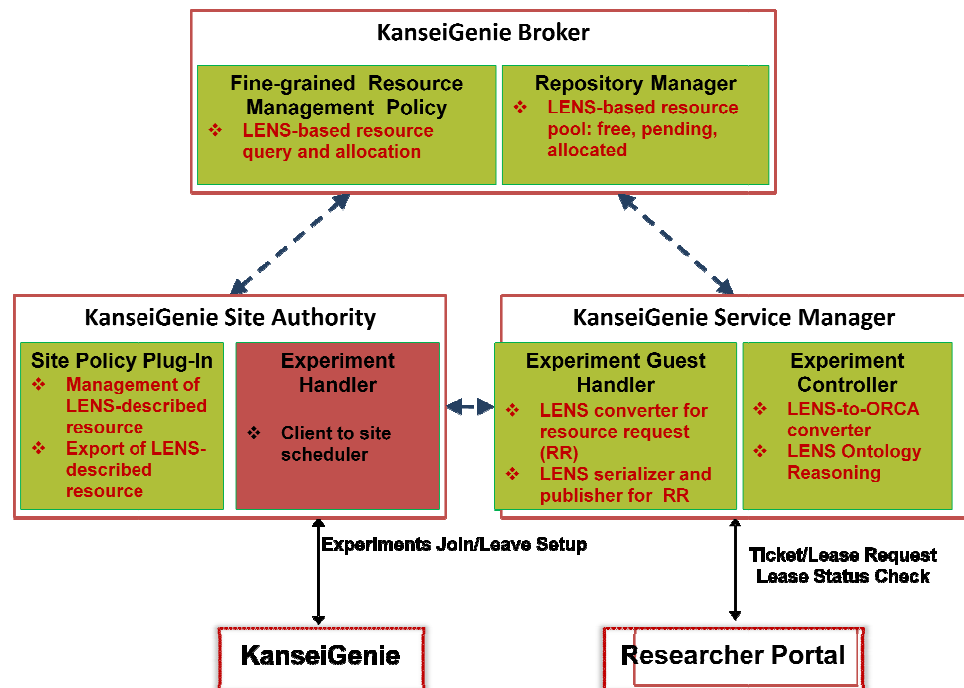


- Designed, implemented the Language for Embedded Networked Sensing (LENS) as the RSpec language for wireless sensor networks, and integrated LENS with KanseiGenie-ORCA control framework
  - Design principles
    - Distinguish specified properties as *controlled* or *observed*
      - Controllable factors: co-channel interference, etc
      - Observable-only factors: slow time-varying wireless path loss, etc
        - Controllability is context-specific: control by “choice” in WSN federations (e.g., for path loss exponent)
    - Enable reasoning about *relationship/dependencies* among resources
      - Channel relation (e.g., path loss) between nodes
      - Correlation among links
    - Whole-lifecycle resource management
      - Support different use cases in resource request, delegation/allocation, monitoring, and release

- o LENS ontology



- o Integration of LENS with KanseiGenie-ORCA control framework



- Developed KanseiGenie Researcher Portal for whole-lifecycle experiment control, including experiment and resource specification, resource request/redemption, infrastructure health monitoring, and VLAN/IP connectivity management


**KanseiGenie**

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**KanseiGenie: A Consortium of Sensor Testbeds for At-Scale Federated Experimentation**

Welcome anish


**1. Kansei Testbed**



Kansei provides a testbed infrastructure to conduct experiments on various wireless platforms, including 802.11, 802.15.4, and 900 MHz Chipcon CC1000 radios, as well as diverse sensor node platforms, including XSM, Telosb, iMote2 and Stargates. Currently, Kansei consists of 96 Kansei Nodes. Each Kansei node comprises of one XSM, 4 Telosbs, and one iMote2, all of which are attached to a Stargate. The Stargates are connected using both wired and wireless ethernet. The Kansei testbed is now part of the [Global Environment for Network Innovation \(GENI\)](#) project. Kansei testbed is now being federated with [NetEYE](#) testbed in Wayne State University. The Kansei project is headed by [Anish Arora](#).

**Kansei Node:**  
The stargates serve as the local gateway for each Kansei node. This allows the Kansei interface to directly program and communicate with each attached sensor node over a wired connection. The [Stargate](#) is a 32-bit class device purchased from [CrossBow](#) running [Stargate Release 7.2](#) from [Intel Research](#). 802.11b Wireless Networking cards ([SMC2532W-B](#)) are installed on each stargate with requisite software ([HostAP](#)), external antennas, and device housings. Kansei makes use of the [EmStar](#) stargate development environment.

**2. NetEye Testbed**



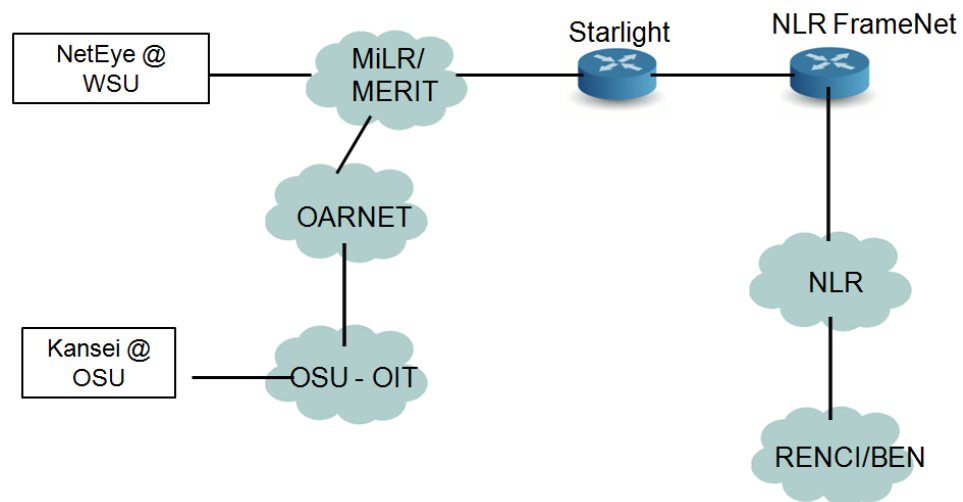
NetEye consists of 130 TelosB notes (with IEEE 802.15.4 radios), 15 Dell Vostro laptops (with IEEE 802.11 b/g radios), and one compute server which are deployed in State Hall --- the Computer Science building at Wayne State University. In addition to providing a local facility for supporting research and educational activities, NetEye is being connected to Kansei as a part of the Kansei consortium; Kansei consortium is initiated to enable experimentation across shared, widely distributed sensornet testbeds at organizations such as Wayne State University, The Ohio State University, Los Alamos National Laboratory, and ETRI, Korea. NetEye and the Kansei consortium are designed and implemented to be interoperable with [NSF GENI \(i.e., Global Environment for Network Innovations\)](#), and, through funding from the NSF GENI program, are being incorporated into the national GENI facility. NetEye also provides live sensing data (e.g., environmental noise, temperature, and humidity) that can be used to drive experimentations and to provide useful information about occupational health in urban universities.

Kansei Status Summary	
Stargates Available	=> 92
Stargates Down	=> 23
Stargates Busy	=> 0
Telosbs Available	=> 368
Telosbs Down	=> 14
Telosbs Busy	=> 0
Experiments Currently Running	=> 0
Experiments Pending	=> 0
Experiments Completed in last 24 hours	=> 0
Experiments Completed in past week	=> 0

Neteye Status Summary	
Stargates Available	=> 15
Stargates Down	=> 15
Stargates Busy	=> 15
Telosbs Available	=> 130
Telosbs Down	=> 2
Telosbs Busy	=> 0
Experiments Currently Running	=> 0
Experiments Pending	=> 2
Experiments Completed in last 24 hours	=> 4
Experiments Completed in past week	=> 7

- Demonstrated maturity of KanseiGenie by supporting public experiments since 2008
  - Researchers from 20+ institutions used KanseiGenie testbeds on a regular basis; the institutions include
    - UCLA
    - Northwestern
    - UT - Dallas
    - ICT (Australia)
    - Ohio State University
    - Michigan State University
    - University of Southern California
    - Stanford
    - SUNY –Buffalo
    - Wayne State University

- City University of Hong Kong (China)
  - University of Sci. & Tech. (China)
  - Southeastern University (China)
- Constantly being used for experiments, e.g.,
  - 2,000+ experiments during Jan-July 2011
  - 500+ experiments during July 2011
- Enabled KanseiGenie federation beyond Kansei and NetEye
  - OKGems @ Oklahoma State University
  - TUNIE @ Tsinghua University (China, in progress)
  - X-Senosr @ Osaka University (Japan, in exploration)
- Established VLAN connectivity between OSU and WSU, and with the broader GENI infrastructures



## 2. Milestones achieved

- KANSEI: 1a Import a GENI-compliant control framework based on ORCA
  - Done
- KANSEI: 1b Establish Kansei testbed clearinghouse
  - Done
- KANSEI: 1c Refactor Kansei researcher portal
  - Done

- KANSEI: 1c2 Integrate Kansei researcher portal
  - Done
- KANSEI: 1d1 Refactor Kansei component and aggregate managers
  - Done
- KANSEI: 1d2 Integrate Kansei component and aggregate managers-
  - Done
- KANSEI: 1f Demo basic virtualization and experiment control functions
  - Done
- KANSEI: 1g Open Kansei testbed to GENI users
  - Done
  
- KANSEI: S2.a Remote access
  - Done
- KANSEI: S2.b Cluster plan for VLANs between testbeds
  - Done
- KANSEI: S2.c Extend researcher portal to support workflow management
  - Done
- KANSEI: S2.d Extend researcher portal for use with Kansei and NetEye
  - done
- KANSEI: S2.e Bring up NetEye testbed at WSU
  - done
- KANSEI: S2.f Connections from Kansei and NetEye to Internet2
  - done
- KANSEI: S2.g Import extended ORCA v2.1 (Due 07/20/10)
  - done
- KANSEI: S2.h Demo experiment using Kansei and NetEye (Due 07/20/10)
  - done
- KANSEI: S2.i Collaborate with GMOC (Due 08/31/10)

- done
- KANSEI: S2.j POC to GENI response team
  - Done
- KANSEI: S2.k POC to GENI security team
  - Done
- KANSEI: S2.l Contribution to GENI outreach (Due 08/31/10)
  - Done
  
- KANSEI: S3.a Demonstration at GEC9 and experimenter outreach
  - Done
- KANSEI: S3.b Documentation
  - Done
- KANSEI: S3.c Demonstration at GEC10 and experimenter outreach
  - Done
- KANSEI: S3.d Documentation
  - Done
- KANSEI: S3.e Demonstration at GEC11 and experimenter outreach
  - Done
- KANSEI: S3.f Final report and code release
  - Done

### **3. Deliverables made**

- KanseiGenie researcher portal for federated use of KanseiGenie testbeds, including Kansei and NetEye  
<http://kansei.cse.ohio-state.edu/KanseiGenie/>
- Detailed documentation for KanseiGenie:  
<http://kansei.cse.ohio-state.edu/KanseiGenie/Doc/index.php>
- KanseiGenie workflow/tutorial
  - <http://kansei.cse.ohio-state.edu/KanseiGenieFed/Doc/tutorial.php>



- KanseiGenie software installer package:  
<http://kansei.cse.ohio-state.edu/KanseiGenie/Downloads/index.php>
  
- KanseiGenie Doctor
  - <http://ceti.cse.ohio-state.edu/siefast/group/publications/bapat2007tridentcom.pdf>
  - <http://portal.acm.org/citation.cfm?id=1462190>
  
- LENS-based resource specification:
  - <http://www.cs.wayne.edu/~hzhang/group/publications/LENS-WiNTECH11.pdf>
  - <http://neteyesa.cs.wayne.edu/rspec>
  - <http://groups.geni.net/geni/attachment/wiki/Gec8Workshops/KanseiGenie-RSpec-GEC8.pdf>
  - <http://groups.geni.net/geni/attachment/wiki/Gec7ResourceRepresentationWorkshop/KanseiGenie-RSpec.pdf>
  
- Fine-grained resource management plugin for KanseiGenie-ORCA control framework
  
- L2/L3 connection switch:  
An option that researchers can choose from during experiment scheduling.
  
- GENI-fied NetEye  
<http://neteye2.cs.wayne.edu>

#### **4. Project participants**

##### **Investigators:**

[Anish Arora](#)

[Hongwei Zhang](#)

[Rajiv Ramnath](#)

[Vipul Gupta](#)

[Sami Ayyorgun](#)

##### **Staff:**

[Mukundan Sridharan](#)

[Wenjie Zeng](#)

Xi Ju

## 5. Publications

- Xi Ju, Hongwei Zhang, Wenjie Zeng, Mukundan Sridharan, Jing Li, Anish Arora, Rajiv Ramnath, Yufeng Xin, "LENS: Resource Specification for Wireless Sensor Network Experimentation Infrastructures", *6th ACM International Workshop on Wireless Network Testbeds, Experimental evaluation and Characterization (WiNTECH)* (in conjunction with ACM MobiCom'11), 2011
- Mukundan Sridharan, Wenjie Zeng, William Leal, Xi Ju, Rajiv Ramnath, Hongwei Zhang, Anish Arora, "From Kansei to KanseiGenie: Architecture of Federated, Programmable Wireless Sensor Fabrics", *6th International Conference on Testbeds and Infrastructures for the Development of Networks and Communities (TridentCom)*, 2010
- Mukundan Sridharan, Wenjie Zeng, William Leal, Xi Ju, Rajiv Ramnath, Hongwei Zhang, Anish Arora, "KanseiGenie: Software Infrastructure for Resource Management and Programmability of Wireless Sensor Network Fabrics", *Next Generation Internet Architectures and Protocols*, Krishna Moorthy Sivalingam et al. (editors), Springer, 2011

## 6. Outreach activities

- Allow open access to KanseiGenie testbeds for researchers/students at various institutions such as Michigan State University, SUNY-Buffalo, Ohio State University, and Wayne State University
- Present KanseiGenie to a delegation of female Ph.D. students from the Mideast, May 2009 (Wayne State University)
- Present KanseiGenie and NetEye to visitors from GM Research, October 2009 (Wayne State University)
- Present KanseiGenie and NetEye to visitors from Ford Research, December 2009 (Wayne State University)
- Present KanseiGenie and NetEye to visitors from GM Research, Feb. 2010 (Wayne State University)

- Present KanseiGenie and NetEye to visitors from Carnegie Mellon University, Feb. 2010 (Wayne State University)
- Present KanseiGenie and NetEye to visitors from Ford Research, March 2010 (Wayne State University)
- Demonstrate KanseiGenie to minority students of the NSF BPC Information Management and Systems Engineering (IMSE) program at Wayne State University, January 22, 2011 (Wayne State University)
- Demonstrate KanseiGenie to a delegation of 30 college students from Shanghai University, China, June 2011 (Wayne State University)

## **7. Collaborations**

- Collaborate with Cluster-D projects as well as other clusters (e.g., OMF) on GENI RSpec
- Collaborate with Cluster-D projects to identify integration strategies with ORCA control framework
- Collaborate with Cluster-D projects to identify VLAN connectivity within the cluster
- Help the team from Oklahoma State University to port KanseiGenie software package to their testbed
- Collaborate with GMOC, exported KanseiGenie health meta data

## **8. Other Contributions**

- Contribute to the following GENI Working Group activities:
  - RSpec workshops
  - Providing feedback to the GENI Control Framework Requirements
  - Giving presentations and demos at all the GECs
- Operational support for experimenters using Kansei and NetEye
- Coordinated with RENC/Duke in contributing to ORCA control framework the LENS language for wireless sensor network resource specification