



**Complex Adaptive System of Systems
(CASoS) Engineering Initiative**
<http://www.sandia.gov/CasosEngineering/>

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Development of an Agent Based Epidemiological Model of Beef Cattle

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- Sandia National Laboratories (SNL)



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- Funding: New Mexico Small Business Assistance Program (NMSBA)
- Model Conceptualization: Robert Glass, Stephen Conrad, Aldo Zagonel, Walt Beyeler, Melissa Finley
- Model development (student interns): Chrysm Watson Ross, John Harger



- New Mexico State University (NMSU) Extension Service

- Clay Mathis, Robert Hagevoort, John Wenzel



New Mexico Livestock Board (NMLB)

- Myles Culbertson, Dave Fly, Tim Hanosh

Ranchers representing the beef and dairy industries

- Joe Gonzalez (Gonzalez Family Dairy)
- Butch Mayfield (Superior Livestock/Mayfield Ranch)
- Phil Bidegain (T4 Cattle Company, LLC)



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Industry Impact of Bovine Tuberculosis

- New Mexico's Tuberculosis Free status lost in 2008
- Significant negative economic impact
 - Logistics
 - Marketing



- Need to evaluate policies
 - Minimize likelihood of outbreak
 - Protect TB free status in clear regions of NM

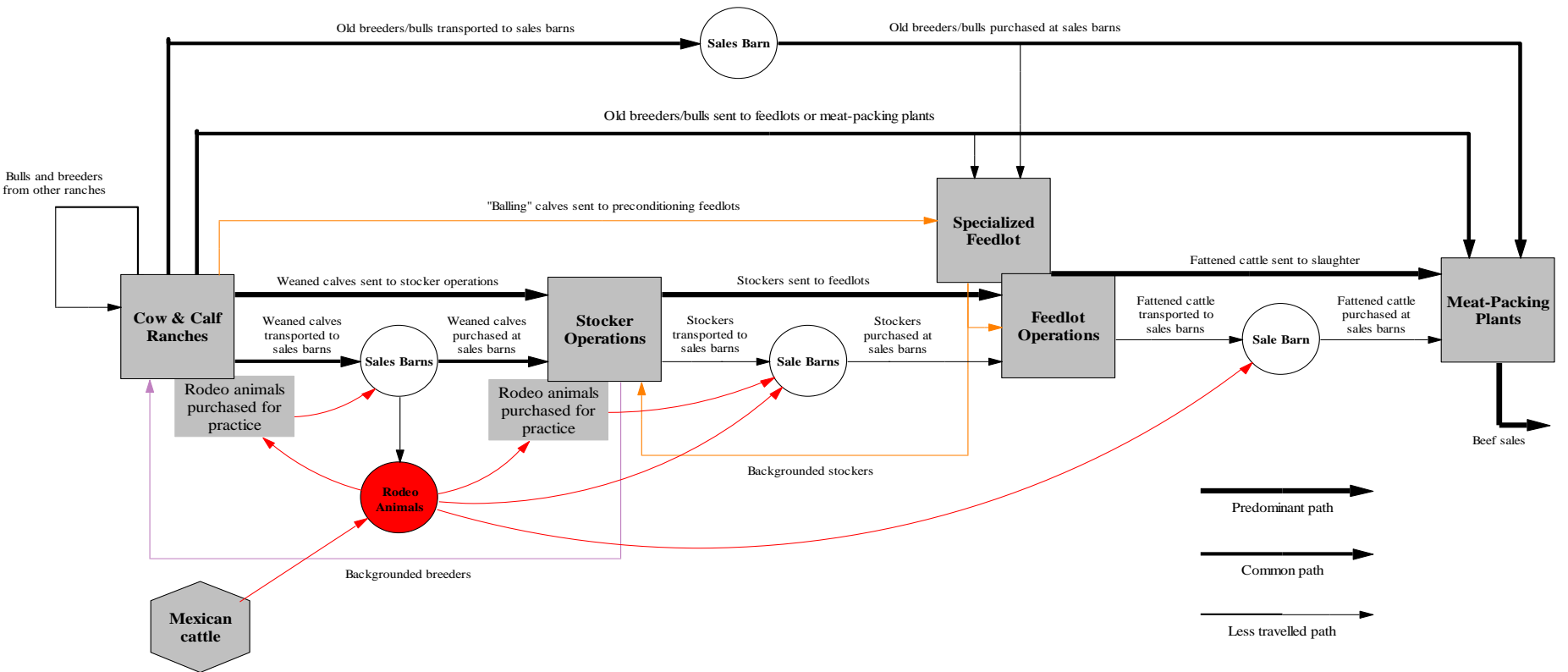
Complications in Tracking Tuberculosis

- Can be asymptomatic for years
- Often only discovered post mortem in meat packing plants
- Traceback from meat packing plant complicated by multiple facilities in the animal's lifecycle chain and thus a large number of potential sources and transmission points of infection.
- Expensive and difficult to test for in some facilities
- Increased viral shedding over time.



- Assist the New Mexico cattle industry in disease tracing and analysis to inform and evaluate prevention and mitigation for bovine tuberculosis:
 - Analyze statistical likelihoods of source, contact points and endpoint of disease propagation through stochastic network modeling
 - Given location of disease identification, identify other potential carriers
 - Cost effectiveness of identification at different points in the lifecycle chain
 - Evaluate the effectiveness of various mitigation protocols

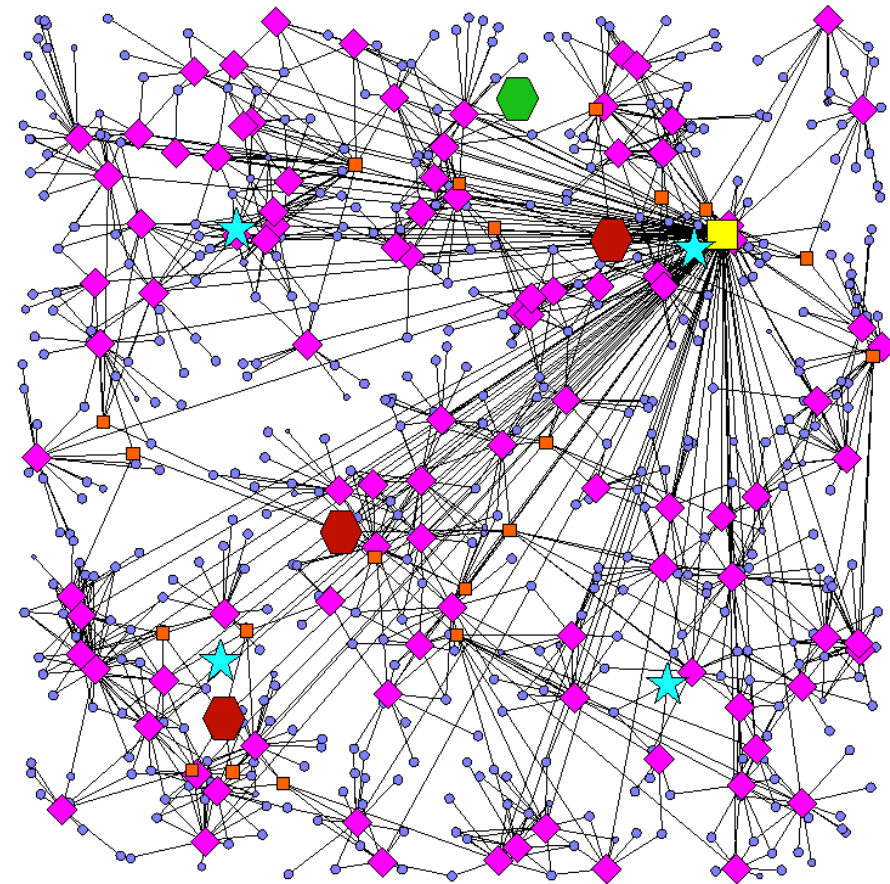
Beef Cattle Life Path



The Agent Based Model

- Discrete units to inform geographic dispersion patterns
- Illuminates regional affects
- Assists with assessing effectiveness of policy boundaries
- Programmed in Java, XML, and Eclipse IDE
- Implemented modules of Loki project

Geographic vs. Abstract Networks



Geographic vs. Abstract Networks

