

Taming Uncertainty and Heterogeneity in Resource Specification for WSN Federations

KanseiGenie Team:

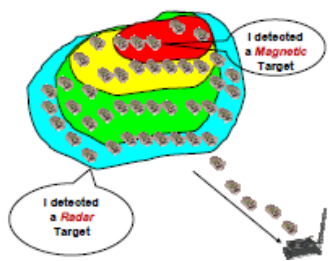
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WSN experimental infrastructures



A Line in the Sand



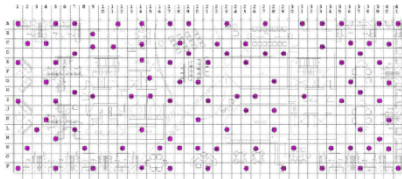
ExScal



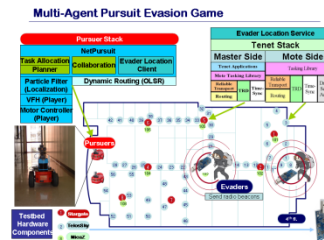
VigilNet



NetEye
WSU



Mirage
Intel



Tutornet
USC



Mirage
UMN



CitySense

Lack of experiment predictability/repeatability

- Conflicting experiment observations
 - Examples
 - wireless interference model (physical vs. protocol)
 - data collection protocol (for periodic monitoring vs. bursty events)
 - Major cause: many uncertainty factors are left unspecified, unmeasured, and implicit
- WSN resource specification is difficult
 - Complex dynamics and uncertainties in WSN
 - Heterogeneous platforms, protocols, and applications

Outline

- Principles and mechanisms of WSN RSpec
- WSN RSpec in NDL
- WSN federation architecture and RSpec implementation
- KanseiGenie RSpec roadmap in Spirals 2&3

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RSpecs for uncertainty factors

- Principle #1: Distinguish specified properties of interest as *controlled* or *observed*
 - Controllable factors: co-channel interference ...
Observable-only factors: slow time-varying wireless path loss ...
 - Controllability is context-specific: control by “choice” in WSN federations
 - Path loss exponent ...
- Mechanism: System choose/maintains controllable factors, and monitor/measures observable factors
 - RSpec embedding, passive/active monitoring techniques
 - Resource provisioning for monitoring

RSpec for heterogeneous, federated WSNs

- Principle #2: Embrace *heterogeneity/diversity* in RSpec
 - Heterogeneity in resource and resource ontology
 - No consensus on basic issues such as WSN addressing (IP or not)
 - Heterogeneity in RSpec use cases
 - Multiple levels of abstraction: low-level specs for system interactions, high-level specs for researchers and opt-in users
- Mechanism: Enable ontology mapping
 - From high-level spec to low-level spec
 - Between heterogeneous low-level specs

Network-centric WSN RSpec

- Principle #3: Enable reasoning about relationship/dependencies among resources
 - Geometric relation among nodes, channel relation (e.g., path loss) among nodes, correlation among links
 - Dependencies among node, radio, and spectrum
- Mechanism: Network-centric measurement and embedding
 - Passive/active monitoring techniques for characterizing relationships/dependencies
 - RSpec embedding

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WSN extension to NDL: examples

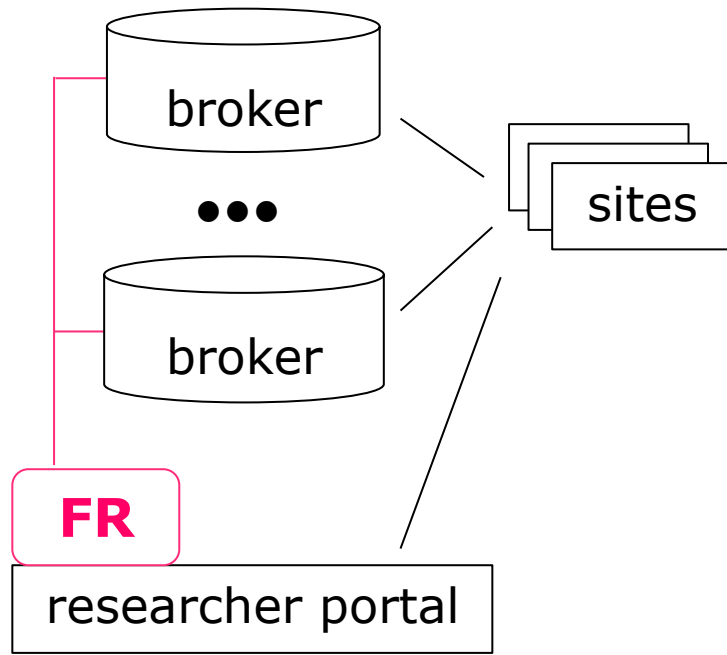
- Radio
 - High-level: standard-based spec such as Zigbee and WiMedia
 - Low-level: wireless spectrum, modulation , (programmable) network stack
- Neighborhood
 - High-level: connectivity (e.g., neighborhood size)
 - Low-level: node location, link properties, *correlation among links* ...
- Environment
 - High-level: application context (e.g., home vs. industrial)
 - Low-level: path loss, *interference from co-existing nets* ...

Outline

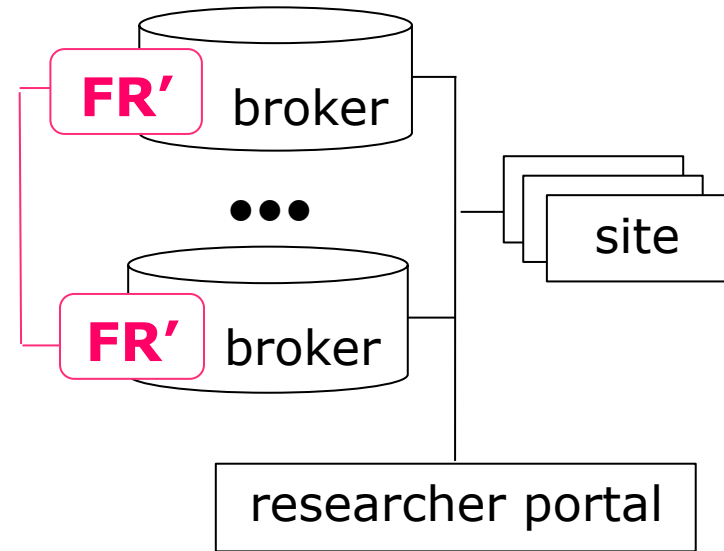
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WSN federation architecture

Federated resource manager (FR): resource discovery and allocation

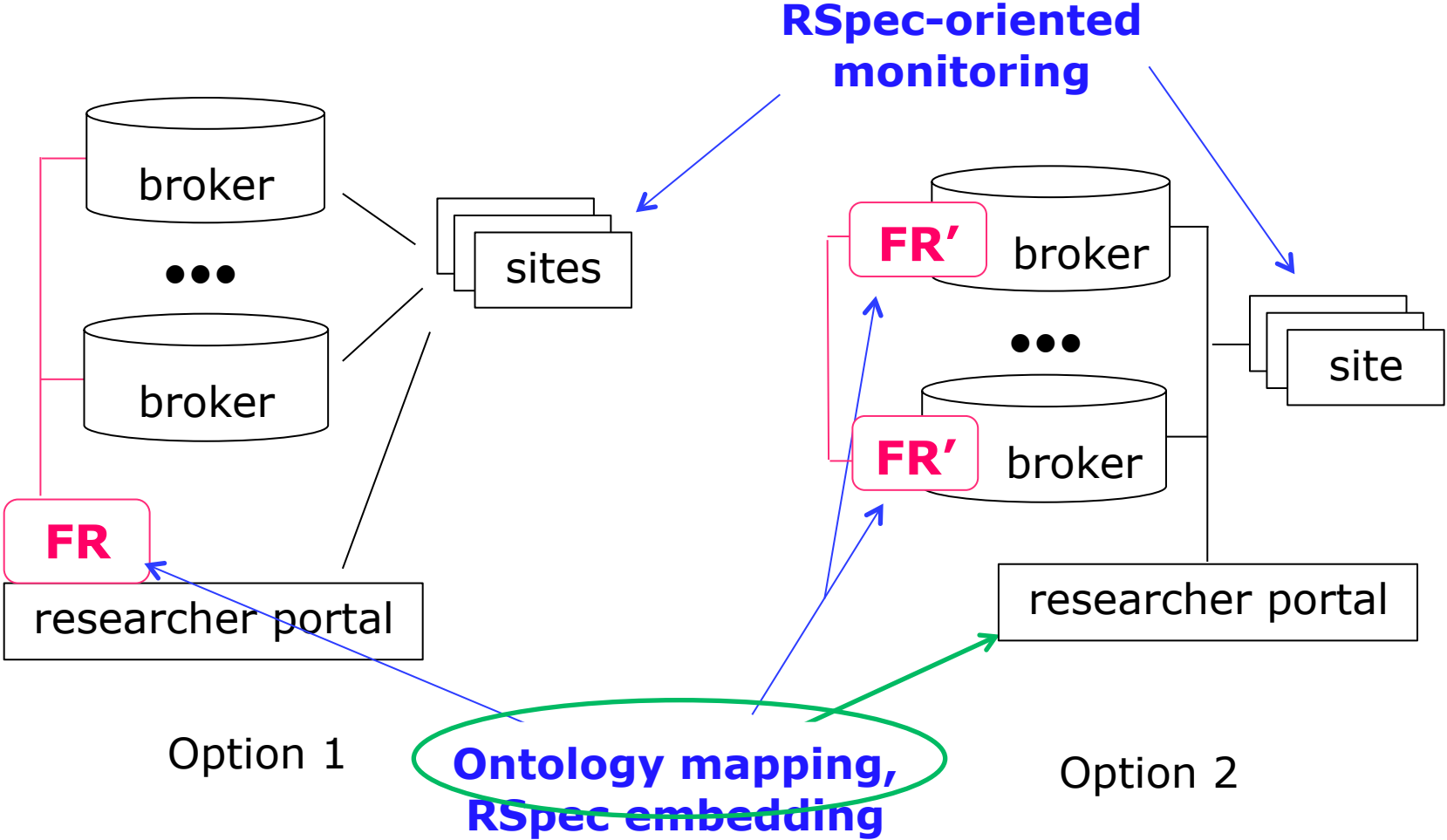


Option 1



Option 2

RSpec implementation



Outline

- Principles and mechanisms of WSN RSpec
- WSN RSpec in NDL
- WSN federation architecture and RSpec implementation
- **KanseiGenie RSpec roadmap in Spirals 2&3**

RSpec roadmap

- Spiral 2
 - Basic WSN RSpec
 - platform and network topology specification
- Spiral 3
 - Basic RSpec-oriented monitoring
 - Refined WSN resource-allocation/RSpec-embedding policies
 - Basic ontology mapping at researcher portal