Information exchanges between router agents

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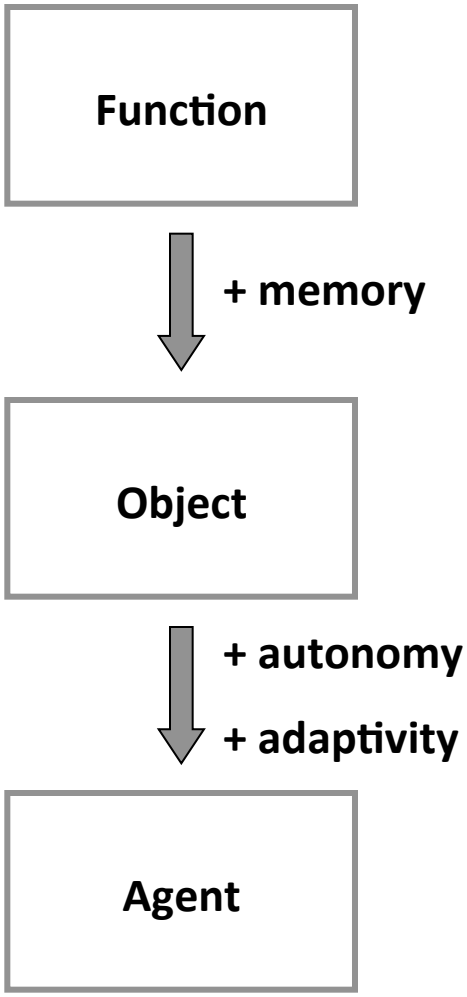
What's an agent ?

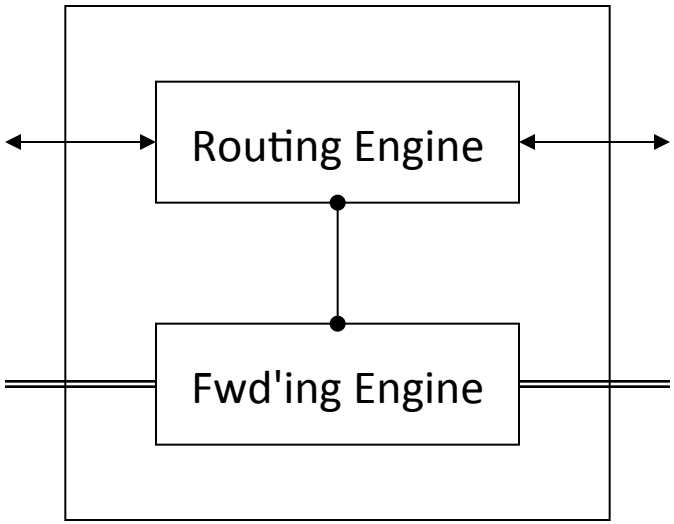
- What is an agent?
  - Autonomous and adaptive decision-making discrete entity with heterogeneous properties, individual/ shared goals and modifiable behaviors
- Agents have internal states (attributes, data,...): memory storing observations (descriptions, representations of environment, etc.)
  - Agents interact with their environments beyond concurrent state-determined interaction
  - Adapt decision on future action to environment changes: using sequence of ***k*** observations of ***k*** past system state (next action not solely dependent on previous state but depends also on some memory)

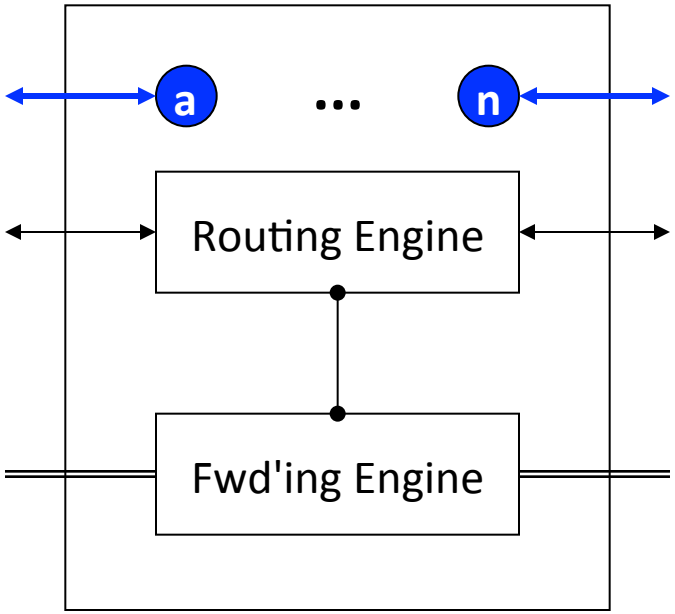
    ... but also on using agent's beliefs about other agents or the utility of performing some actions, etc.



Router's Agent

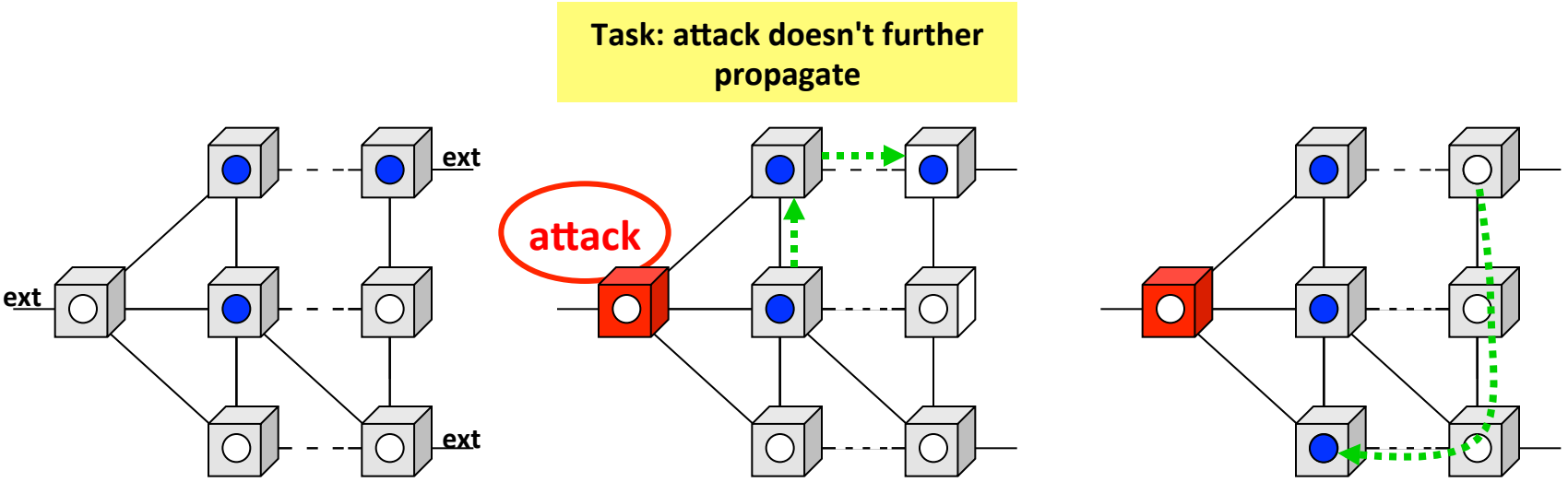
- Agents i running on routers (N:1), $0 \leq N < \infty$





Multi-Agent System

- Non-uniformly distributed set of interacting (software) agents
- Each agent receives a separate partial observation of the environment
- No central control entity shared between agents



When agent are running on routers

- Their communication process: different space- and time-scale
- Their communication channels are "ad-hoc"
- No modification of the routing system boundaries (AS or areas)

Applications

Two classes

- Networking layer-related
  - Diagnostic, analysis
  - Distributed intrusion detection, immunity
- Others
  - Information routing related (caching/storage, processing, etc.)
  - etc.

In both cases, different objects / information units than those associated to legacy network layer routing (link states, vector, etc.)

Routers' components programmability is by definition going to accelerate these trends

Communication between agents: Current situation

- Routing protocols (network layer information exchange and processing)
  - vectors
  - states

  } -> compute routes

- The "multi-", "opaque-", "extended-" ... problems (because of communication-memory-processing cost)

  1) PUSH mode: inefficient when applications are operate at different time and spatial-scale

  2) Overlaying is only one out of many means to add functionality (-- D.Wheeler quote)

  3) Determinism vs uncertainty (stochastic nature of events, interactions, environment, etc.)

- Corollary (out of 3): pushing the uncertainty out of the routing system (ignore it) will in the long term make the system itself under-performing

Communication between agents: What would we need ?

1) PUSH mode: inefficient when applications are operate at different time and spatial-scale

-> ***Hybrid push-pull*** information communication mode for router's agent to operate at ***multiple time-scale*** and ***multiple space-scale***

2) Overlaying is only one out of many means to add functionality

-> Routers comprise multiple software agents – ***run-time behavior*** (instead of being structured along a stack of functions with static and invariant bindings)

3) Determinism vs uncertainty

-> Impossible to ensure "perfect" placement of agents (impossible to fully anticipate) => ***cooperation*** between agents from interaction patterns

Summary

- Agent: adaptive and autonomous statefull entity (memory) implementing various functions

- If agents run on "routers" (entity hosting routing and forwarding function) then the routing system becomes also a multi-agent environment
  - multi ≡ distributed
  - actually routing and forwarding are also agents but since these agents define the entities themselves and are tightly intricate they are hard to dissociate

- Consequently
  - We need to enable exchange of information between agents to perform
  - **Is the IETF the place to specify this protocol ... BoF in Vancouver**