A Generic Cognitive Adaptive Module (CAM) for MANETs

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Introduction

- A generic Cognitive Adaptive Module (CAM) to be utilized for MANET routing.
- Facilitates the design of adaptive behaviour and cognition in MANET routing protocols
- Motivation: Provisioning of multimedia communications requires routing Quality of Service (QoS) guarantees
- **NP Complete problem** in MANETs (when QoS optimization subject to more than one metric)
- Soft QoS (e.g. based on bounds established stochastically) better option for Multi-metric based route selection process important for wider context usages.
  - **Variations** in higher layer QoS **requirements** and **constraints** (Battery limitations, etc.) require **Adaptive routing** behaviour.

Scenarios

- **Emergency rescuer and military ad hoc communication**
  - Rescuers and military participants require multimedia communications (e.g. **low delay** and **delay jitter** as well as high throughput required) with **limited battery resources**

- **Mesh-based wireless community networks**
  - Community users are likely to access multimedia services using static rechargeable mesh routers. Users might prefer **greener** and **cheaper energy** efficient QoS routing.

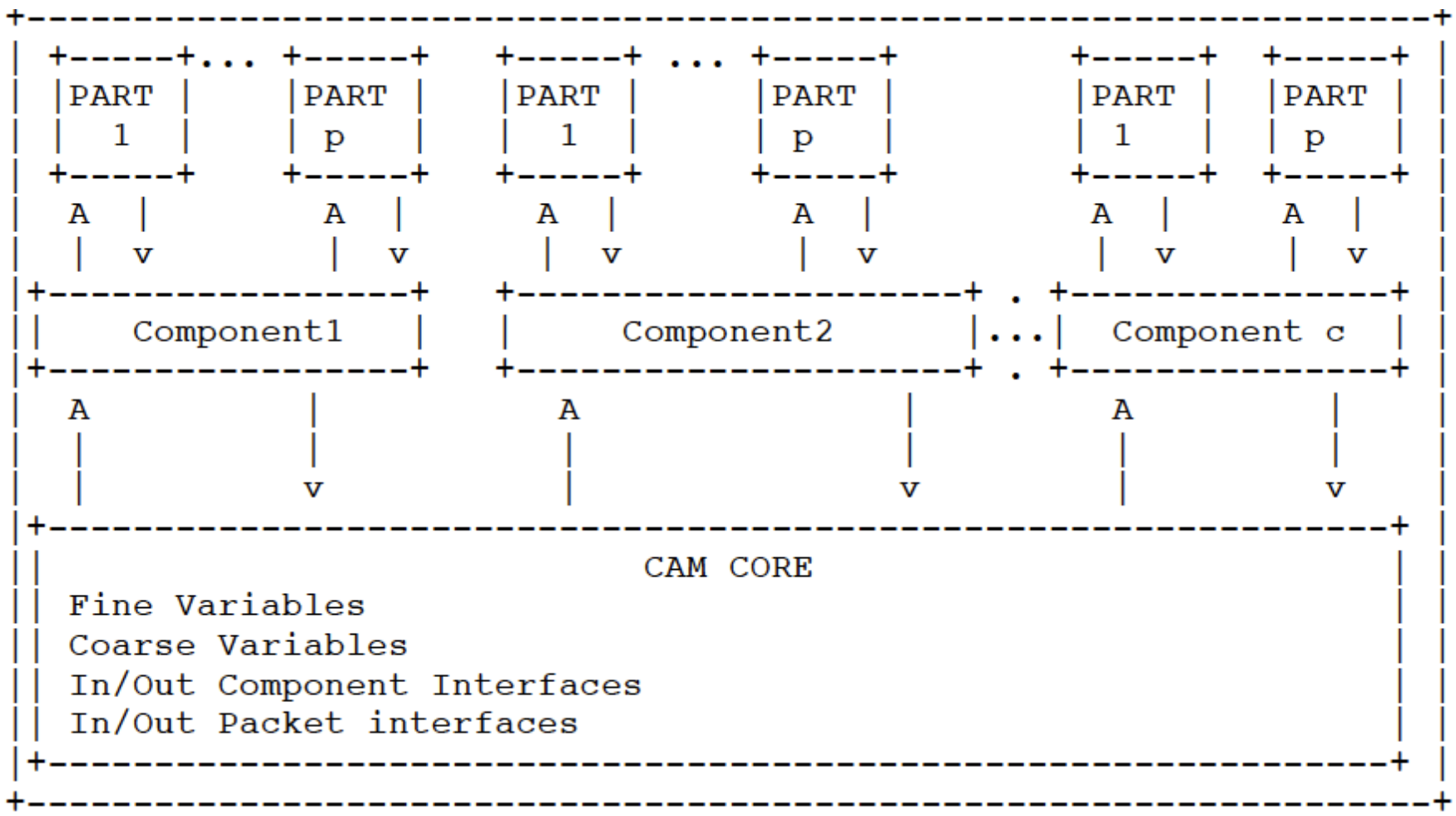
- **Mesh-based wireless enterprise networks**
  - Enterprise users (i.e. office users) are likely to access email and file transfer services (require **low packet loss**). Users might also prefer **greener** and **cheaper** solutions.

- **Smart home ad hoc networks**
  - For content distribution to home devices. **"Bursty"** communication. Proactive maintenance of route information **expensive** for idle periods between bursts.

CAM

- Along the lines of cross-operability rules from **RFC 5444** and routing problem segmentation of **NHDP I-D**.
- CAM allows optimised route selection when **requirements** and **constraints** are change are detected by nodes.
- Routing protocols **configurable** by designers and users at different levels according to scenario requirements.
- In CAM the routing paradigm is segmented into **core**, **components** and **parts**:
  - Interfaces from the CAM core to various user defined components and from each component to its component parts.
- Examples of **Key Components**: Routing, Repositories, Adaptive, Monitor,
- Examples of **Component Parts**: Routing logics (DYMO, OLSRv2, NHDP), Metric selection.

Overview


PART 1
PART p
Component1
Component2
Component c
CAM CORE
Fine Variables
Coarse Variables
In/Out Component Interfaces
In/Out Packet interfaces

Operation (1/2)

- **CORE:** Component-to-Component communication only via the core.
- Component and part IDs - Each component and each component part is identified through a **unique** ID.
- **Thresholds and Triggers** (for adpative behavior) for each monitored context. So that the **trigger** used to contact the Adaptive module if for context C:
  - 1. (Previous_C_Value < Threshold_C) and (Current_C_Value>= Threshold_C)
- **Core Coarse and Fine variables: e.g.** contains ID of parts that the core identifies as active. Can change routing behavior (by changing variable values) according to context changes.
- **CAM Components**: consists of a group of logic **Parts** that allows the utilized routing protocol to operate in a specific manner (e.g. Monitor, Adaptive, Routing, Metric Specification, Packet and TLV specification and Repositories components (Monitor provide cognition to routing protocols), **Security**).

Operation (2/2)

- **Monitor Component:** Contain logic that processes incoming packets and/or data in Repositories component to derive network state information (parts MAY be called monitors)
- Checks the appropriate **threshold** according to the current operating routing logic.
- **Alerts** the CAM core if a threshold is exceeded. **Trigger** then contacts **parts** to cause routing change.
- **Monitors** e.g. Number of neighbors monitor, Rate of change in neighbors, Total number of nodes, Traffic profile monitor, Metric Statistics using metric TLVs (similar to R_etx TLV in [OLSRetx])
- **Adaptive component**: MUST check whether the trigger is **valid**.
- MAY change values for coarse and fine variables **if trigger is valid**.

Use Case: ChaMeLeon (CML) (1/2)

- Hybrid adaptive routing protocol using CAM: provide more flexibility as compared to OLSRv2 and DYMO individually. Allows for easier protocol configuration (e.g. segmentation of logics into protocols – NHDP)

- The Routing Algorithms component: parts include OLSRv2, DYMO, NHDP. The Core coarse and fine variables indicate the mode of operation and the default mode of operation.

- The monitor component: Monitors network size, Monitors the network density. Compares these values with the corresponding threshold values and uses the corresponding triggers from adaptive component.

- Adaptive component: sets appropriate value for TC_HOP_LIMIT according to (node density, number of nodes).

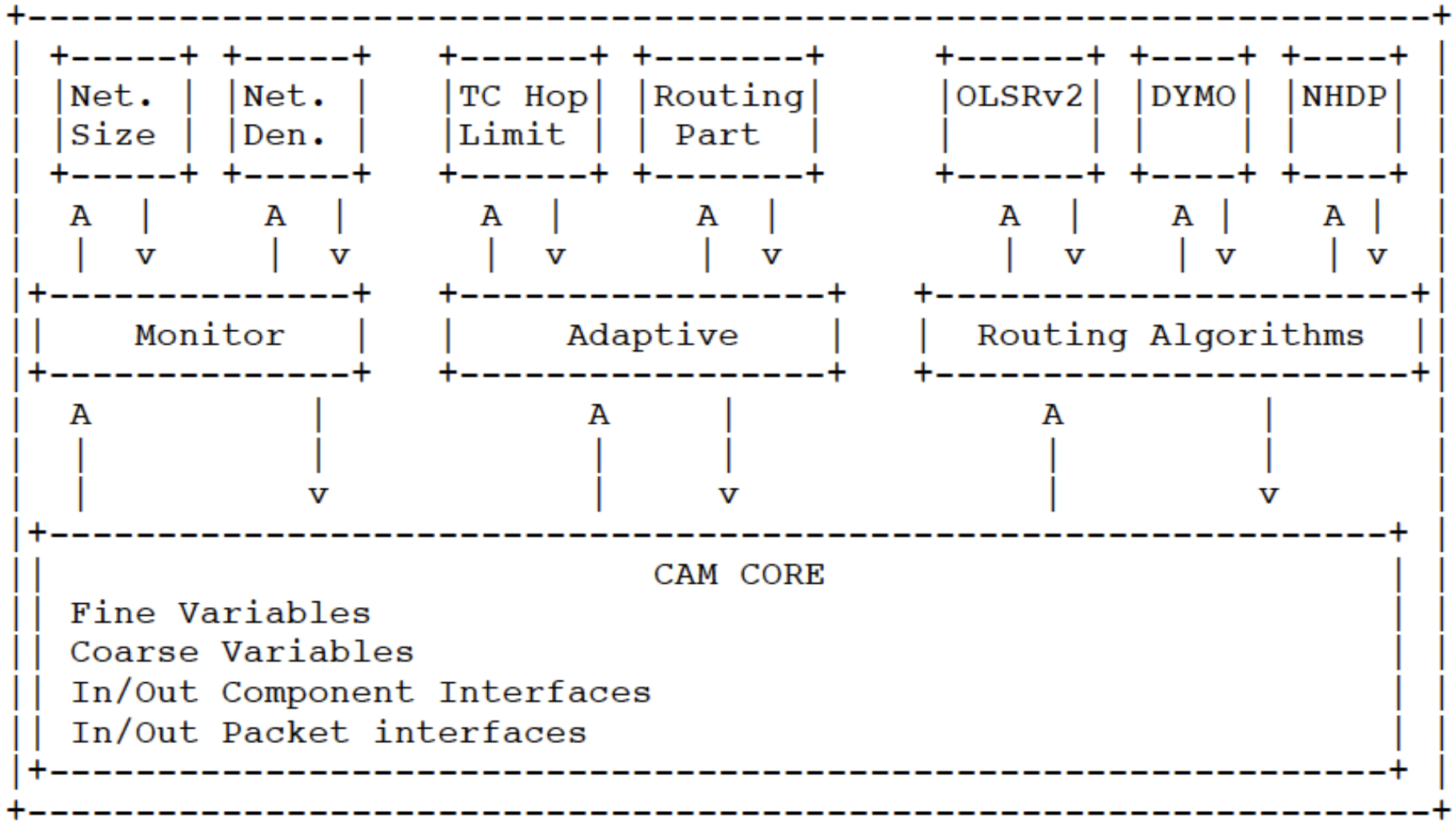
Use Case: ChaMeLeon (CML) (2/2)

- Routing Algorithms component: Uses OLSRv2 routing logic by default
  - can Process packets RREQ (unicasted to destinations found in the proactive routing table, flooded through MPR nodes if destination is not in proactive routing table, and relevant information stored in the reactive routing table)
  - Can process RREP (unicasted towards the source node using the reactive table RREQ information if the proactive table does not contain an entry for such a source.)

- Uses routing logic of DYMO to:
  - Generate reactive routing packets when routes to destinations are not found in the proactive table.
  - NHDP packets used for local route maintenance and TC packets forwarded.

- Route quality determination: for quantifying route qualities using defined metrics from a "Metric Statistics" part of the "Monitor component".
  - SHOULD allow for a multiple metric based path selection process.
  - Metric quantization: hierarchical based metric quantization (prioritisation of route metrics), route utility score, or hybrid approach

CML Operation



Conclusion

- Hybrid adaptive routing protocol easily designed and configurable using CAM.
- Routing logic can be segmented into components and then into parts such as NHDP.
- Each part can have configuration interfaces and can be standardised.
- The parts can be used optionally by MANETs depending on context.
- The parts can be used on an adaptive basis by encoding the required logic that is controlled via the CAM core.
- This should allow for the use of MANET routing protocols in a wider context range in an efficient manner.

Thank you!

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