CONSERN

COOPERATIVE AND SELF-GROWING ENERGY-AWARE NETWORKS

Adapting to change (from Construction to Usage to Re-purposing)

Outline

- Self - Growing Network – the concept
- Self - Growing – the evolution path
- Self - Growing – the parameters
- CONSERN Scenarios and Use Cases
- Use Case: Dynamic Meeting Setup Flexible Office/Building Environments
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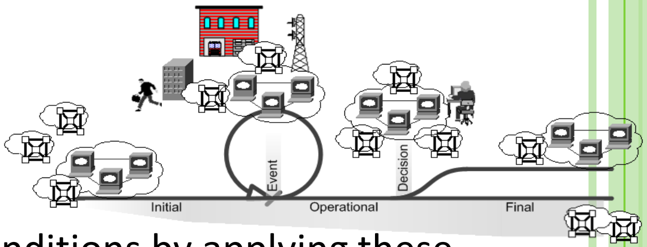
- The way forward

Self-Growing Network – the concept

- A self-growing network is introduced and defined as “a novel type of network composed of (heterogeneous) network nodes and sub-networks that can cooperate and utilize their reconfiguration capacity to optimize on-demand for a dedicated (temporary) purpose”.
- A self-growing network is considered a novel concept since
  - It is purpose-driven,
  - It follows a predetermined path in its functional evolution, and its capacity to implement multiple purposes along this path.
- A Self Growing network is utilizing state-of-the-art concepts and enablers to realize this evolution, such as
  - Node and network reconfigurability,
  - Cognitive decision-making, and,
  - Self-learning capacity.



- A Self Growing network can respond to exceptional operating conditions by applying these concepts and enablers to define a temporary purpose satisfying demands arising from the exceptional situation.
- A self-growing (from “progress to maturity”) network thus can be seen as a managed autonomous network guided (from “educating” or “raising”) in its evolution by bounding rules.
- It is assumed, and has to be proven, that this approach is more suitable for low-profile, resource-limited node and network architectures compared to full autonomic network solution.

Self-Growing – the evolution path (1/2)

- A self-growing network follows some rules of evolution along its lifecycle
  - A predetermined progression from purposes requiring a lower level of complexity towards purposes requiring a higher level of complexity regarding reconfiguration and collaboration capacities.
  - The degree of freedom to deviate from a planned lifecycle is a matter of the purpose of a self-growing network.
  - The optimal balance between the autonomic and cooperative paradigms may be different according to the purpose of the self-growing network.
  - This will be reflected in the rules that govern the evolution of the network, favouring (and motivating) varying degrees of cooperation between the network elements.

Self-Growing – the evolution path (2/2)

- The following key elements define the self-growing:
  - A **lifecycle** is defined as either self-determined or pre-planned path along a sequence of **progression points** that define (potentially temporary) stable points in the evolution of a self-growing network.
  - Progression points can be associated with stable configurations of a network potentially providing different functionalities for a certain purpose of the network.
  - A lifecycle is defined as having one well-defined starting point and one or more potential end-points, as well as an arbitrary number of intermediate points, each of them defined by a progression point.
  - A **progression point** shall associate with a set of **attributes**.
  - These attributes can be described each by a non-empty set of parameters.
  - If a set of metrics is made available for these parameters, the progression point is measurable.
  - An associated descriptive set of factors (i.e., values of parameters) then makes a progression point well defined.
  - Since the transition from one progression point to the next along the lifecycle is measurable in terms of parameter changes, it also implicitly describes the benefit (or cost) obtained from an evolutionary step.

Self-growing – the parameters

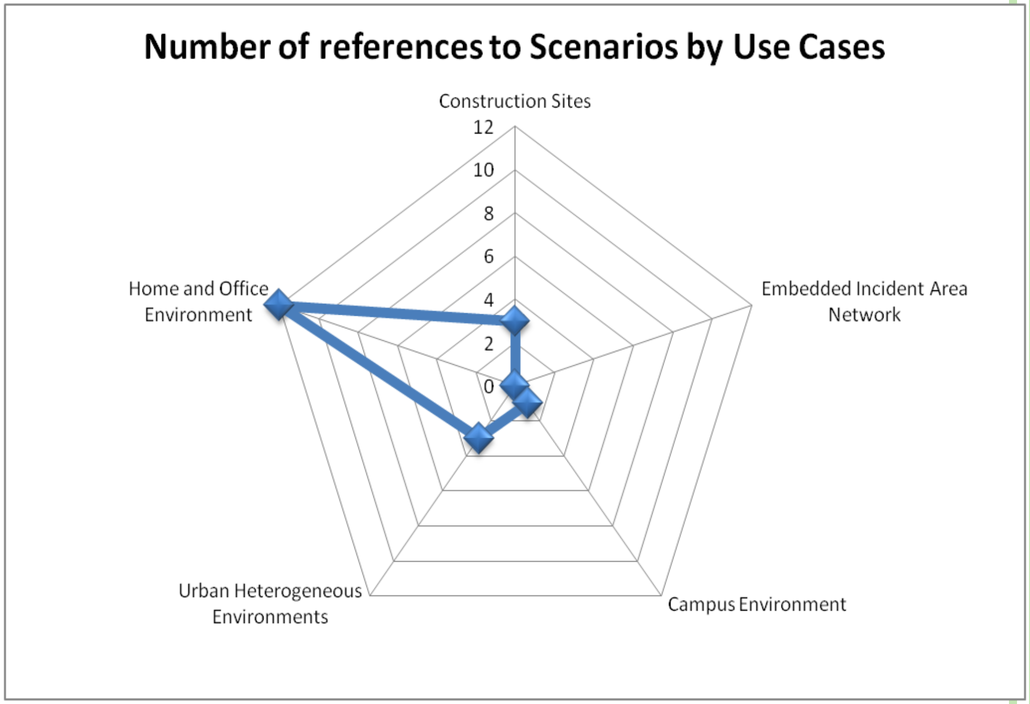
- A parameter is used to detail specific aspect of an attribute.
- The Self-growing as an attribute is detailed through the following parameters:
  - Change in number of purposes a network is dedicated to,
  - Change in number of nodes (over network lifetime),
  - Change in network topology,
  - Change in network configuration,
  - Change in set of purposes a network supports,
  - Amount (and complexity) of human intervention needed to add a device to the network,
  - Amount (and complexity) of human intervention needed to add a new purpose to the network,
  - Number of self-growing enabling nodes per service area,
  - Node spread and location in the service area,
  - Change in node spatial distribution,
  - User/Node distribution in the service area,
  - Number of active/idle nodes in the network,
  - Set of possible routes connecting each node with the backbone.

CONSERN Scenarios and Use Cases (1/2)

- Scenario 1: Construction Sites
  - Addresses both wide-area and in-facility construction sites as well as moving work zones.
  - Network evolution is achieved by deploying heterogeneous equipment and by continuously updating operational policies.
- Scenario 2: Embedded Incident Area Network
  - Addresses the deployment of a network in a limited geographical area.
  - In case of an exceptional event – responding to a management action or to a notification by sensors a **temporary switch of purpose** then will designate the network, part of the network or single network nodes to implement an incident area network until the incident is resolved.
- Scenario 3: Home and Office Environment
  - Addresses the deployment of a heterogeneous wireless network in a limited geographical area, such as a home and office environment.
  - Such a network guarantees the provision of voice and data communication services, but also acts as a large scale, distributed and cooperating system for monitoring and control, incorporating Wireless Sensor Networks.
- Scenario 4: Urban Heterogeneous Environments
  - Addresses the network deployment within an urban area with offices where people are working and homes where people are living.
  - As people, on a daily basis, move between offices and homes the need for network resources grows and shrinks. The main objective of the scenario is to find ways to support the needed communication in an energy efficient manner.
- Scenario 5: Campus Environment
  - Extension of the home and office environment scenario,
  - addresses a kind of evolution of a collection of independent home and office environments into a larger scenario, both in terms of number of nodes, area covered, coexistence problems encountered, or increasing collaboration and functional enhancements opportunities.

CONSERN Scenarios and Use Cases (2/2)

- A trend towards the Home and Office Environment related Use Cases
- Many key aspects of those scenarios can be straightforwardly extended to other contexts
  - Construction Sites,
  - Embedded Incident Area Networks,
  - Campus Environments,
  - Urban Heterogeneous Environments, etc.
- In the framework of the project, it is expected that some key features
  - will be considered and studied in other contexts
  - tailored to other applications when this is deemed useful or required.



Use Case: Dynamic Meeting Setup Flexible Office/Building Environments

- Overview
  - One company has reserved a public meeting room to hold a meeting with a few project partners.
  - People in the meeting have different roles and different rights for using surrounding communication technologies or accessing resources of the other stakeholders
  - Initial network access is provided by the owner of the public meeting room, but is temporary owned by the meeting organization company.
  - The result is a quite complex and dynamically changing networking setup with several roles, rights, restrictions, and policies.
- Goals
  - Integration of different types of networking technologies.
  - Enabling of network partitioning based on rules, policies, and profiles.
  - Allowing planning and scheduling as well as life cycle management of virtual/temporary network partitions.
- Highlights
  - The use case is suited for building/office and (primarily) indoor environments.
  - Several networking technologies are involved (wired, wireless, powerline).
  - Several roles and stakeholders are involved
    - Building/Office/Facility Lessor.
    - Building/Office/Facility Leaser/Renter,
    - Third Parties.
  - The use case may dynamically change in space/coverage and service.

Use Case: Cognitive Coexistence and self growing for white space operation

- Scenario 5: Campus Environment
- Overview
  - Focus on a locally deployed access point operating in white spaces in order to form a WLAN providing access to a small (company) network.
  - During its lifetime, the capabilities of the device dynamically grow from an operation without coexistence to a fully coexisting operation mode with other white space devices deployed in the surrounding.
  - In a second phase, the self-growing of the network, the purpose of the deployed network elements grows from only supporting nomadic mobility to additionally supporting seamless mobility for mobile users.
- Goal
  - Increasing coexistence in case of difficult wireless situations or optimizing energy consumption vs. wireless coverage benefit (e.g., range extension).
  - Illustrate how self-growing enables additional services and allows to fully exploiting the capacity available via the wireless medium by growing from a separated heterogeneous infrastructure deployment into an integrated homogeneous or interacting network.
- Highlights
  - A cognitive decision engine achieves separation in (used) spectrum by intelligently assigning valid spectrum portfolios to devices.
  - The rules of the decision engine at each device are updated to allow a technology specific detection of other (heterogeneous) devices in communication range.
  - Where applicable, the cognitive decision engines may decide to trigger a reconfiguration of devices enabling direct communication among existing networks.
  - This self-growing phase enables additional services.
    - Wireless links among deployed devices allow to distribute the traffic among several low-bandwidth wired connections
    - Existing homogeneous network elements to support nomadic mobility of the end-user

The way forward

- The Self-Growing Framework is comprising:
  - The use cases and scenarios
    - Based on the further elaboration on use cases analysis and selections, the use cases will be part of the framework in different degrees, according to the value they provide in terms of required functionality and benefits,
    - Use Cases have been analysed and a refinement is expected resulting in pure self-growing use cases.
  - The identified and used attributes and parameters and metrics
    - They reflect different aspects and details of the self-growing concepts,
    - Their involvement in the framework will be refined based on the analyses that will be performed to identify and highlight the correlation between the different types of attributes which have been defined,
    - Metrics will be identified to evaluate whether the identified parameters are captured by the system parts.
  - The reference architecture
    - The application of the architecture will be modelled by the use cases and scenarios.
    - The grade of generality is rather changing between scenarios and use cases.
    - Functional requirements and functionality identification have been initiated; elaboration is planned which will result to the first draft self-growing architecture definition,
  - The tools, methods and algorithms used to evaluate the benefit,
    - This work has been started.
  - The environment needed to provide the testing/operating context (either real or simulated).
    - Requirements to the environment have been defined.

COoperative aNd Self growing Energy awaRe Networks

Thank You