



NETWORK ANALYSIS AND ROUTING EVALUATION: THE NARVAL MODULE

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SNT
securityandtrust.lu

**Weicker
Building**



- The University of Luxembourg, founded in 2003, is multilingual, international and strongly focused on research. Its students and researchers have chosen a modern institution with a personal atmosphere, close to European institutions, international companies and Luxembourg's financial centre.
- Interdisciplinary Centre for Security, Reliability and Trust (SnT), created in 2009.
 - European research centre of excellence and innovation in Security and Trust
 - APSIA: Applied Security and Information Assurance
 - A&C: Automation and Control
 - NETLAB: Networking Laboratory
 - RNES: Reliable Networked Energy Systems
 - SERVAL: Security and Validation of Services and Networks
 - SIGCOM: Signal Processing & Satellite Communications
 - SVV: Software Validation and Verification
 - High quality and internationally attractive PhD program
 - Platform for research collaboration with partners



Partnership Program

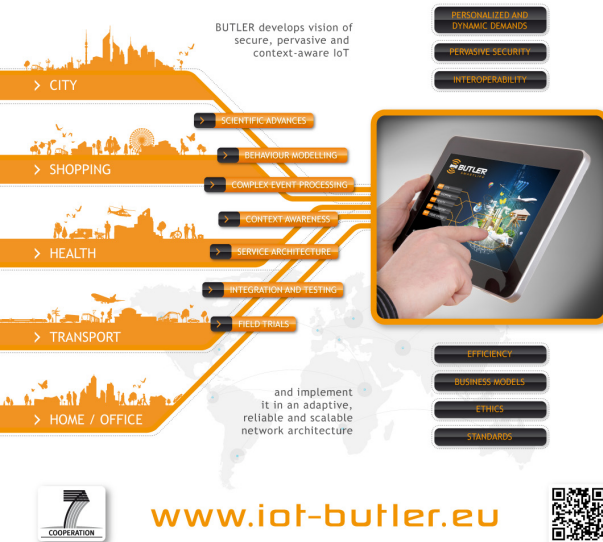
- Platform for interaction and cooperation with industrial and government partners
- Positive impact on the region's business



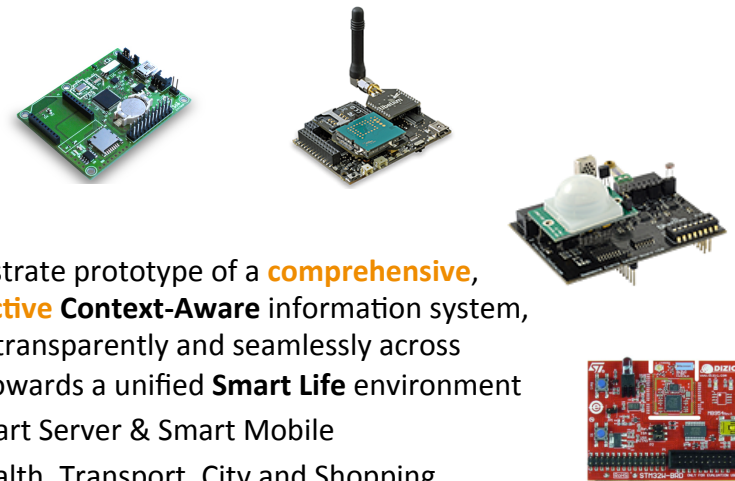
BUTLER Project



uBiquitous, secUre inTernet-of-things
with Location and contExt-awarEness

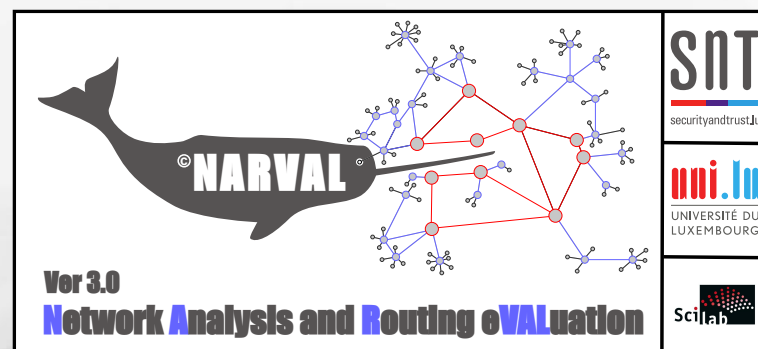
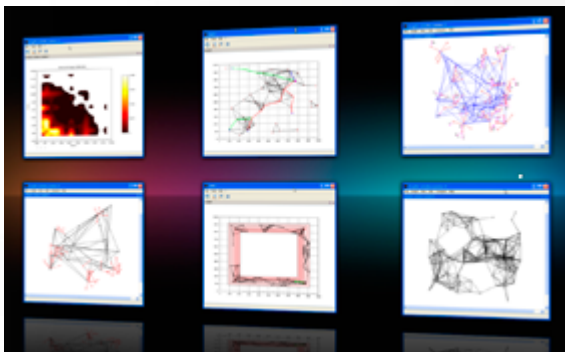


- Design and demonstrate prototype of a **comprehensive, pervasive** and **effective Context-Aware** information system, which will operate transparently and seamlessly across various scenarios towards a unified **Smart Life** environment
- Smart Object & Smart Server & Smart Mobile
- Domain: Home, Health, Transport, City and Shopping
- Internet-of-Things (IoT): Large number of constrained and low cost embedded devices
 - low power consumption (batteries)
 - Limited ROM/RAM (specific Operating Systems: CONTIKI, TinyOS)
 - Wireless communication range (802.15.4) etc.



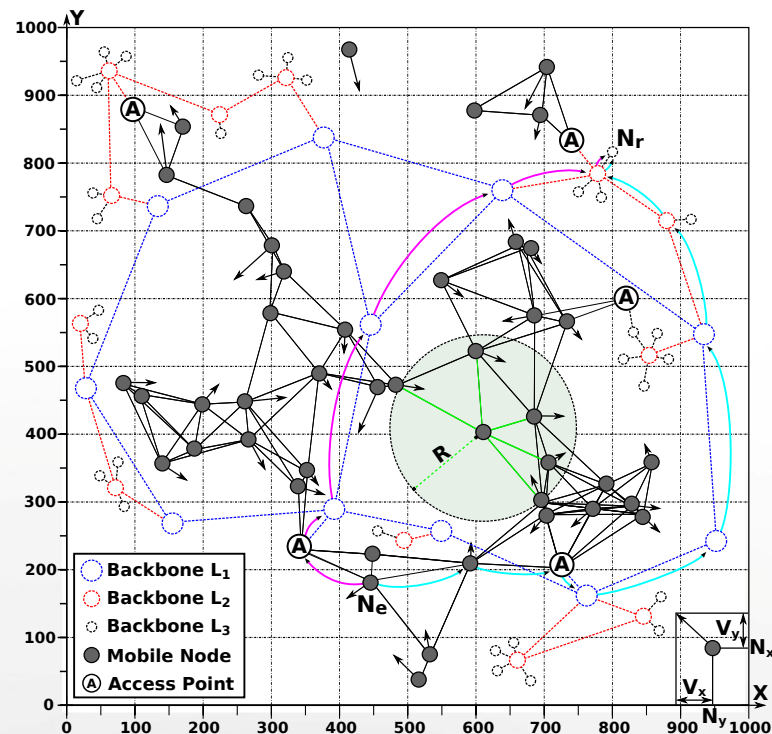
Module Description & Goal

- Analysis of network protocols and algorithms
- NARVAL (Network Analysis and Routing eVALuation)
 - Complete software environment enabling the understanding of available communication algorithms, but also the design of new schemes
 - Graph Optimization, Topology, Internet Traffic, Routing, Transmission Protocol, Route Diversity, Mobility, Security, Anonymity, Path Planning, Wireless Sensor Network, etc.
 - Target audience: academics, students, engineers and scientists



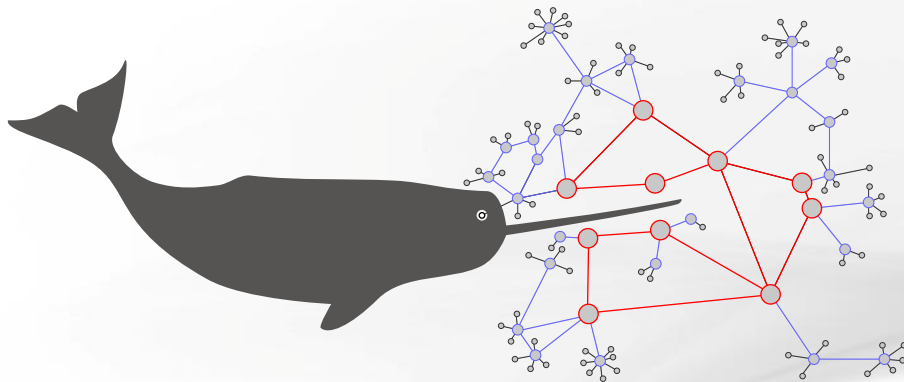
Network Model

- Node $N_i(x_i, y_i, E_i)$
- Link $L_j(H_j, T_j, W_j)$
 - W_j : propagation delay, bandwidth, hop count, traffic load, etc.
- Compute the best path between two nodes N_e and N_r in respect with a specific objective function to optimize



NARVAL Requirements

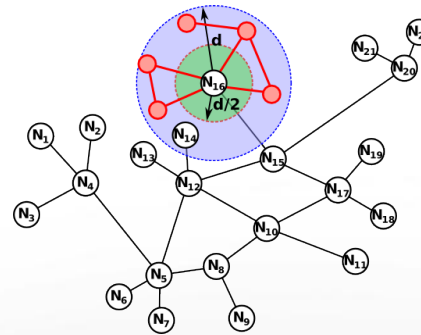
- Scilab $\geq 5.3.3$
- <http://atoms.scilab.org/toolboxes/NARVAL>
- New release is under development and will be uploaded soon (Scilab 5.5.0)



NARVAL Skeleton 1/3

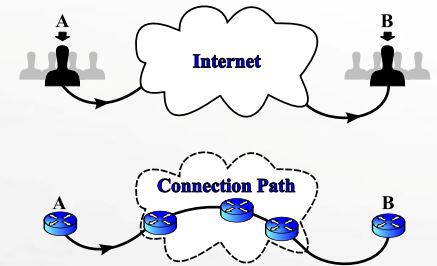
- NL_F (29 functions)

- Random generators,
- Nodes' coordinates,
- Nodes' selection,
- Histogram, Etc.



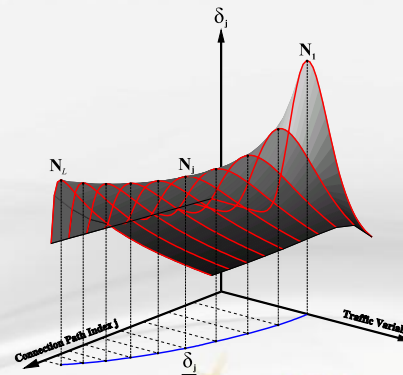
- NL_G (82 functions)

- Graph generation and modification (Addition/deletion of nodes/edges),
- Neighborhood extraction,
- Visualization tools,
- Statistics, Etc.



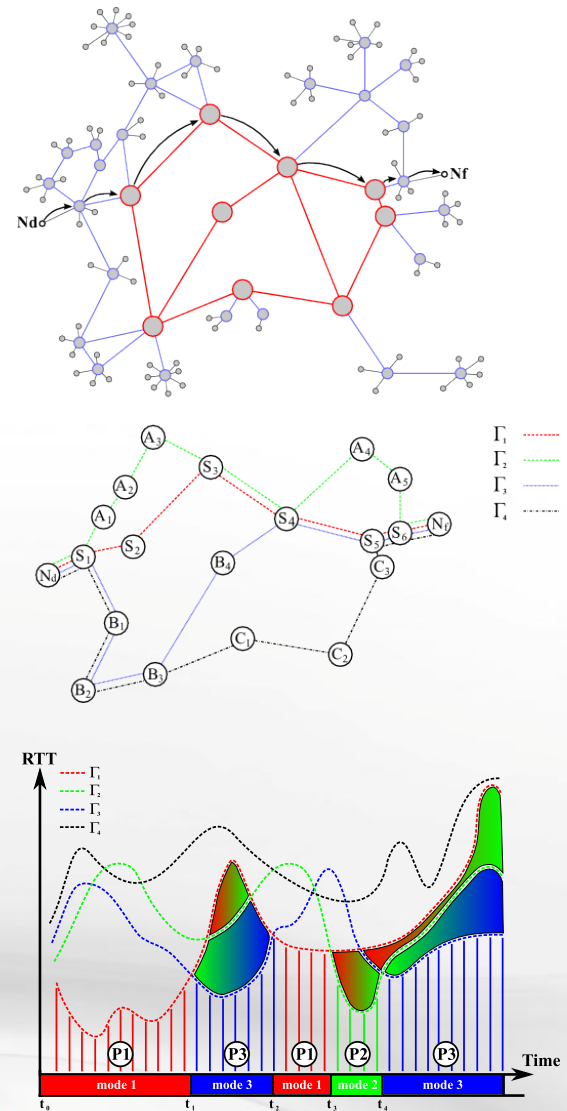
- NL_I (30 functions)

- Connection manager,
- Packet manager,
- Route manager,
- Transport protocols (UDP, TCP, MPTCP) and Sliding window manager, Etc.



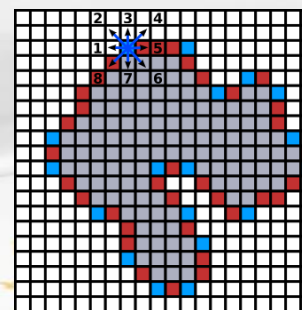
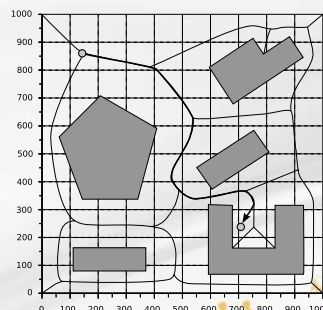
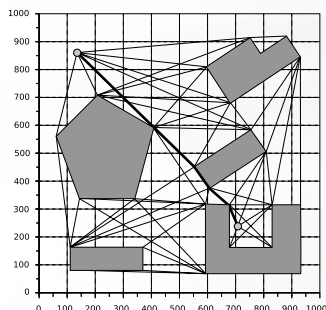
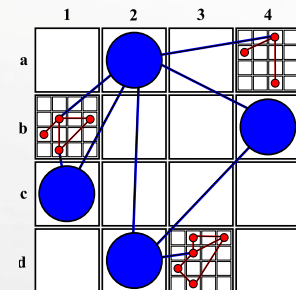
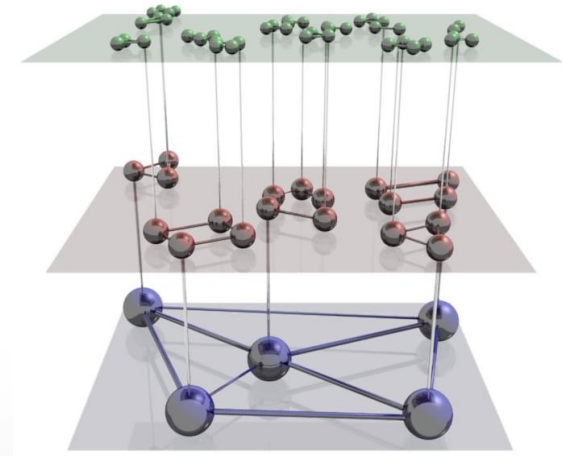
NARVAL Skeleton 2/3

- NL_M (20 functions)
 - MANET/VANET in free/constrained space,
 - Random direction,
 - Random walk,
 - Random way point, Etc.
- NL_R (93 functions)
 - Routing algorithms,
 - AODV,
 - Spanning tree, BFS and DFS,
 - Bellman-Ford, Dijkstra, Flood, RPL and ARC, Etc.
- NL_S (34 functions)
 - Network security,
 - AES encryption/decryption,
 - RSA encryption/decryption,
 - Information slicing, Etc.



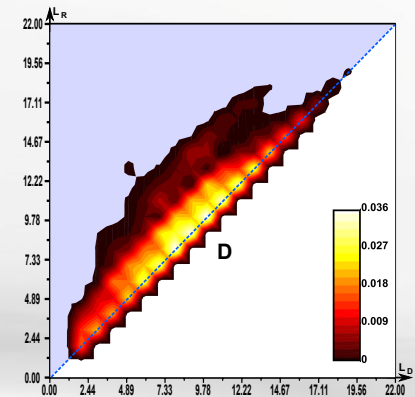
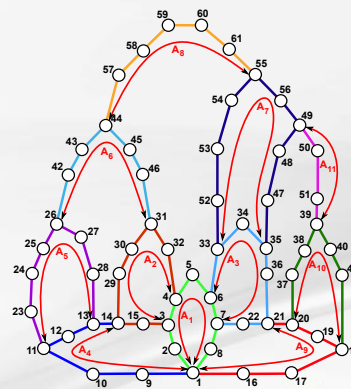
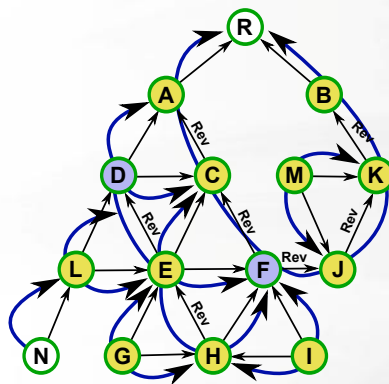
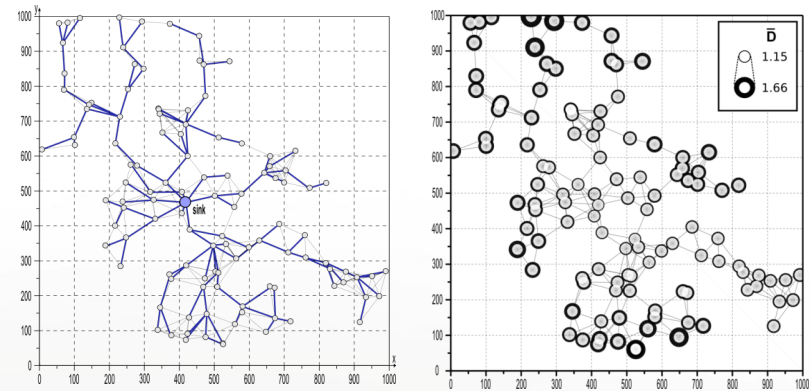
NARVAL Skeleton 3/3

- NL_T (13 functions)
 - Topology generator,
 - Waxman algorithm,
 - Locality model,
 - Hierarchical model, Etc.
- NL_V (29 functions)
 - Path planning in constrained environment,
 - Scene definition with obstacles,
 - Computer vision algorithms (dilatation, erosion, Moravec, etc.)
 - Visibility graph, Etc.



Current Research with NARVAL

- Path extension analysis of P2P communication in small 6LoWPAN/RPL networks (MASCOTS'13)
 - Longer paths imply larger energy waste
 - Statistical analysis of point-to-point communications (path hop length) inside random Wireless Sensor Network (WSN) topologies (L_R : RPL & L_D :Dijksra)
 - Impact of the sink location, the network size
- Towards a new way of reliable routing: multiple paths over ARCs



Conclusion & Perspective

- NARVAL (Network Analysis and Routing eVALuation) is a Scilab module enabling the understanding of available communication algorithms, but also the design of new schemes in order to evaluate and improve the traffic behavior and distribution on network topologies defined by the user.
- <http://atoms.scilab.org/toolboxes/NARVAL>
- Future work
 - Networking: DNS, DHCP, etc.
 - New topology generators
 - Fault tolerance: global repair vs local repair
 - Data aggregation: Wireless Sensor Network
 - Localization algorithms: Cooperative vs Non-Cooperative
 - Routing Algorithms: RIP, DYMO, DSR, OLSR (MPR), OSPF, ACO, etc.
 - Mobility: Gauss-Markov, smooth random, reference point group, obstacle, Markovian random walk, simple individual mobility markovian, generic individual mobility markovian, etc.





THANK YOU !

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www.iot-butler.eu